Transport Canada Transports Canada

Transportation of Dangerous Goods

CONTAINERS FOR TRANSPORT OF DANGEROUS GOODS BY RAIL, A TRANSPORT CANADA STANDARD

TP 14877E

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TABLE OF CONTENTS

1 SCOPE 1

1.1 ORGANISATION AND CONTENT 1
1.2 MINIMUM REQUIREMENTS 1
1.3 ADDITIONAL REQUIREMENTS 1
1.4 UNITS 1
1.5 INTERPRETATION 2

2 REFERENCED PUBLICATIONS 3

2.1 REFERENCES 6
2.2 REFERENCE CONFLICTS 6

3 DEFINITIONS 7

3.1 GENERAL 7

4 GENERAL REQUIREMENTS 18

4.1 APPLICATION 18
4.2 CONTINUED USE 18
4.3 EQUIVALENCY 18
4.4 OTHER CONTAINERS 18
4.5 CLASSIFICATION 18
4.6 SCHEDULE 1 AND SPECIAL PROVISIONS 18
4.7 SCHEDULE 2 AND LIST OF DANGEROUS GOODS 19
4.8 CONFLICT 19
4.9 DANGER TO PUBLIC SAFETY 19
4.10 CLOSURES 19
4.11 TANK CAR INTEGRITY AND CONTINUED USE 20
4.12 TANK CAR CLEANING PRIOR TO CONDUCTING WORK 20

5 QUALITY MANAGEMENT SYSTEM 21

5.1 SCOPE 21
5.2 APPLICATION 21
5.3 GENERAL REQUIREMENTS 21
5.4 SPECIFIC ELEMENTS AND PROCESSES OF THE QUALITY MANAGEMENT SYSTEM 21

6 REGISTRATION, APPROVALS AND CERTIFICATION 24

6.1 REGISTRATION OF TANK CAR FACILITIES LOCATED IN CANADA 24
6.2 PROCEDURE FOR SECURING APPROVAL OF TANK CARS 24
6.3 CERTIFICATE OF CONSTRUCTION 25
6.4 SERVICE EQUIPMENT APPROVAL 25
6.5 REGISTRATION BY MANUFACTURER OR INDEPENDENT INSPECTOR OF TON CONTAINERS 25
6.6 REGISTRATION OF TON CONTAINER PERIODIC RETEST FACILITIES 26

7 MARKINGS 28

7.1 SCOPE 28
7.2 TANK CAR STENCILLED MARKINGS 28
7.3 IDENTIFICATION PLATES 29
7.4 QUALIFICATION AND CONVERSION MARKINGS 30
7.5 DELAYED INSTALLATION 30

8 MANUFACTURE AND MODIFICATION OF TANK CARS AND TON CONTAINERS FOR TRANSPORT OF DANGEROUS GOODS 31

8.1 GENERAL 31
8.2 GENERAL TECHNICAL AND SAFETY SYSTEM REQUIREMENTS 31
8.3 GENERAL REQUIREMENTS APPLICABLE TO TC CLASS 111 TANK CAR TANKS, TC CLASS 117 TANK CAR TANKS AND TC PRESSURE TANK CAR TANKS 40
8.4 GENERAL REQUIREMENTS APPLICABLE TO TC CLASS 115 TANK CAR TANKS CONSISTING OF AN INNER CONTAINER SUPPORTED WITHIN AN OUTER SHELL 61
8.5 GENERAL REQUIREMENT APPLICABLE TO TC CLASS 106A AND TC CLASS 110A TON CONTAINERS 71
8.6 GENERAL REQUIREMENTS APPLICABLE TO CLASS TC 113 VACUUM-INSULATED TANK CAR TANKS FOR CRYOGENIC LIQUIDS 78

9 QUALIFICATION AND MAINTENANCE OF TANK CARS AND TON CONTAINERS 97

9.1 SCOPE 97
9.2 GENERAL REQUIREMENTS 97
9.3 TANK CAR QUALIFICATION 97
9.4 REQUIREMENTS FOR QUALIFICATION AND MAINTENANCE OF TANK CAR STUB SILLS. 97
9.5 REQUIREMENTS FOR QUALIFICATION OF TANK CARS 99
9.6 ACCEPTABLE RESULTS OF INSPECTIONS AND TESTS 108
9.7 MAINTENANCE 109
9.8 REPORTING AND RECORD RETENTION REQUIREMENTS 110
9.9 PERIODIC RETEST AND INSPECTION OF TON CONTAINERS 111

10 SELECTION AND USE OF CONTAINERS FOR THE HANDLING, OFFERING FOR TRANSPORT, OR TRANSPORTING OF DANGEROUS GOODS BY RAIL 114

10.1 SCOPE 114
10.2 SELECTION AND USE 114
10.3 SAFETY SYSTEMS 115
10.4 LOADING LIMITS AND OUTAGE 117
10.5 SPECIFIC DANGEROUS GOODS 120
10.6 LOADING AND UNLOADING RAILWAY VEHICLES 126
10.7 LOADING OF CONTAINERS 127
10.8 AFTER LOADING 128
10.9 BEFORE TRANSPORTING 129
10.10 RAIL OPERATING RESTRICTIONS 129

11 PROVISIONS FOR THE ONE TIME MOVEMENT OF NON-CONFORMING CONTAINERS PRESENTING LOW SAFETY RISKS 131

11.1 SCOPE 131
11.2 WRITTEN NOTIFICATIONS 131

11.3 LOW SAFETY RISK APPROVALS 131
11.4 MOVEMENT OF CERTAIN NON-CONFORMING TON CONTAINERS 135

APPENDIX A – SIDE IMPACT TEST FOR TC 117P 136

APPENDIX B – HEAD IMPACT TEST FOR TC 117P 137

APPENDIX C – PROCEDURES FOR TANK-HEAD PUNCTURE-RESISTANCE TESTING 138

APPENDIX D – PROCEDURES FOR SIMULATED POOL-FIRE AND TORCH-FIRE TESTING 140

APPENDIX E - SCHEDULES 143

SCHEDULE 1 – SPECIAL PROVISIONS 143
SCHEDULE 2 – LIST OF DANGEROUS GOODS 162

1 SCOPE

1.1 Organisation and Content

The standard applies to the design, manufacture, maintenance and qualification of tank cars and ton containers and the selection and use of large means of containment or transport units used in the handling, offering for transport or transporting of dangerous goods by rail of Classes 2, 3, 4, 5, 8, 9 and Division 6.1. This standard does not apply to large means of containment that are used exclusively for non-dangerous goods. It consists of eleven sections and five appendices. Section 1 is an introduction outlining the general scope. Sections 2 and 3 provide a list of referenced publications and definitions. Section 4 sets out general requirements and defines the applicability of the standard and the precedence of each section. Section 5 sets out the Quality Management System requirements applicable to Canadian tank car facilities. Section 6 outlines the registration requirements applicable to facilities performing manufacture, inspection, maintenance or qualification of tank cars and ton containers. Section 7 sets out tank car marking requirements. Section 8 sets out tank car and ton container manufacturer and modification requirements. Section 9 sets out the requirements for the periodic qualification and maintenance of tank cars and ton containers. Section 10 covers the selection and use requirements for containers. Section 11 provides some allowances for one time low risk movement of non-conforming containers. Appendices A and B specify procedures and set out acceptance criteria for the side and head impact test for TC 117P tank cars. Appendix C specifies a procedure to test tank car head puncture resistance systems. Appendix D specifies test procedures and sets out acceptance criteria for simulated pool-fire and torch-fire. Finally, Appendix E sets out in Schedule 1 the requirements applicable to special provisions 1 to 87, and Schedule 2 lists dangerous goods and specifies the special provisions that are applicable to each of the listed dangerous goods.

1.2 Minimum Requirements

This standard sets out certain minimum requirements regarding the design, manufacture, qualification, selection and use, or testing of containers. It is essential to exercise competent technical, engineering and safety judgment in conjunction with this standard.

1.3 Additional Requirements

The *Transportation of Dangerous Goods Act, 1992* (TDG Act), and the *Transportation of Dangerous Goods Regulations* (TDG Regulations) may call for additional requirements regarding the design, manufacture, qualification, selection and use, or testing of containers.

1.4 Units

Quantities and dimensions used in this standard are given in metric units with equivalent US customary units shown in brackets where appropriate. The metric units shall be regarded as official in the event of a dispute.

1.5 Interpretation

In this standard the words "must" and "shall" are imperative. The word "may" is permissive.

2 REFERENCED PUBLICATIONS

The following publications are referenced in this standard.

American National Standards Institute (ANSI)

AWS D15.1:2012-AMD1

Railroad Welding Specification for Cars and Locomotives

Association of American Railroads (AAR)

Field Manual of the Interchange Rules, January 5, 2016

Manual of Standards and Recommended Practices

Section C, Car Construction — Fundamentals and Details

Issue of 2014

Standard S-286 (Revised 2016)

Free/Unrestricted Interchange for 286,000 lb Gross Rail Load Cars

Section B

Couplers and Freight Car Draft Components

Issue of 2012

M-901E (Revised: 2015)

Draft Gears with a minimum Capacity of 36,000 ft.-lb. at a Reaction of 500,000 lb.

Section C, Part II

Design, Fabrication, and Construction of Freight Cars (M-1001)

Issue of 2015

Section C, Part III

Specifications for Tank Cars (M-1002)

Issue of November 2014

ASME International (American Society of Mechanical Engineers)

Boiler and Pressure Vessel Code (2015)

Section VIII Pressure Vessels Division 1

ASTM International (American Society for Testing and Materials)

A20/A20M-15

Standard Specification for General Requirements for Steel Plates for Pressure Vessels

A240/A240M-15b

Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A262-15

Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A285/A285M-12

Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength

A302/A302M-12

Standard Specification for Pressure Vessel Plates, Alloy Steel, Manganese-Molybdenum and Manganese-Molybdenum-Nickel

A370-15

Standard Test Methods and Definitions for Mechanical Testing of Steel Products

A515/A515M-10(2015)

Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

A516/A516M-10(2015)

Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service

A537/A537M-13

Standard Specification for Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel

B162-99(2014)

Standard Specification for Nickel Plate, Sheet, and Strip

B209-14

Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

B209M-14

Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

Canadian Standards Association (CSA)

B620, as issued from time to time.

Highway tanks and TC portable tanks for the transportation of dangerous goods

B621, as issued from time to time.

Selection and use of highway tanks, TC portable tanks, and other large containers for the transportation of dangerous goods, Classes 3, 4, 5, 6.1, 8 and 9

B622, as issued from time to time.

Selection and use of highway tanks, TC portable tanks, and ton containers for the transportation of dangerous goods, Class 2

Compressed Gas Association (CGA)

Publication C-1 Edition 11, 2016

Methods for Hydrostatic Testing of Compressed Gas Cylinders

Publication C-6 Edition 11, 2013

Standards for Visual Inspection of Steel Compressed Gas Cylinders.

The Sulphur Institute (TSI)

Molten Sulphur Rail Tank Car Guidance

Issue of November 18, 2010

Transport Canada

TDG Act

Transportation of Dangerous Goods Act, 1992, as amended from time to time.

TDG Regulations

Transportation of Dangerous Goods Regulations, as amended from time to time.

U.S. Department of Transportation (DOT)

US 49 CFR — Code of Federal Regulations, Title 49, Parts 171 to 180 inclusive

Hazardous Materials Regulations

2.1 References

A dated reference in this standard is to the issue specified. An undated reference in this standard is to the latest issue, unless otherwise specified.

2.2 Reference Conflicts

In the case of a conflict between the requirements of this standard and a referenced publication, other than the TDG Act and TDG Regulations, the requirement set out in this standard will take precedence.

3 DEFINITIONS

3.1 General

In addition to the definitions, terms and abbreviations given in the TDG Act and TDG Regulations, the following definitions apply in this standard:

AAR (AAR)

Association of American Railroads.

Alteration (Transformation)

A change in a tank car or service equipment that does not change the specification but that changes the certificate of construction.

Approved (Approuvé)

Approval by the Executive Director.

Assemble (Assembler)

To construct a tank car without welding on the tank car tank.

Bottom Shell (Coque inférieure)

The portion of a tank car tank surface, excluding the heads, which lies within 610 mm (24 in.) of the bottom longitudinal centreline of the tank car tank when measured circumferentially.

Canadian Service (Service canadien)

An expression used to designate a container used in the handling, offering for transport or transporting of dangerous goods with an origin and a final destination within Canada.

Certificate of Construction (Certificat de construction)

A certificate from the manufacturer of a tank car or ton container certifying that the tank car or ton container and service equipment conform to the requirements of clause 4.1.

Certificate of Inspector's Report (Certificat d'inspection)

A certificate and report of an independent inspector, in the form specified by the Director, certifying that the ton container and service equipment conform to the requirements of clause 4.1.

Check Valve (Vanne anti-retour)

A valve that automatically closes to stop the flow of liquid or vapor in one direction.

Class (Classe)

A general designation usually including several tank car or ton container specifications. The word class is used when the designation embraces several specifications. For example the numerals 111 and 106 are classes.

Closure (Fermeture)

A device that closes an opening into a container, or an auxiliary device that closes an outlet or inlet connection on a valve or fitting, including pipe plugs, quick disconnect caps, blind flanges, manway covers, outlet caps, eduction pipe caps, and fill hole covers.

Compliance Mark (Indication de conformité)

Compliance mark as defined in the TDG Act.

Container (Contenant)

A large means of containment as defined in the TDG Regulations.

Conversion (Conversion)

A change in a tank car that changes its specification.

Crude Oil (Pétrole brut)

For the purpose of tank car selection, any of the following:

a. Oil, other than refined petroleum products;
b. A blend of oils, other than refined petroleum products; or
c. A blend of oils, other than refined petroleum products, with refined petroleum products.

Cryogenic Liquid (Liquide cryogène)

A refrigerated liquefied gas that is handled or transported at a temperature equal to or less than -100 °C (-148 °F).

Dangerous Goods (Marchandises dangereuses)

Dangerous goods as defined in the TDG Act, and includes dangerous goods listed in Schedule 2 of Appendix E.

Dangerous Goods Toxic by Inhalation (Marchandises dangereuses toxiques à l'inhalation)

For the purpose of tank car or ton container selection, any one of the following:

a. A liquid, other than a mist, meeting the criteria in the TDG Regulations for Division 6.1, Packing Group I, because of its inhalation toxicity, whether having the classification of Division 6.1 or not, and assigned to Hazard Zone A or B in accordance with clause 10.5.2;
b. A Division 2.3 gas assigned to Hazard Zone A, B, C, or D in accordance with clause 10.5.2; or
c. Any dangerous goods identified as an inhalation hazard by a special provision of Schedule 1 in Appendix E.

Director (Directeur)

The Executive Director, Regulatory Frameworks and International Engagement, Regulatory Affairs Branch, Transportation of Dangerous Goods Directorate, Transport Canada.

Elevated Temperature Dangerous Goods (Marchandises dangereuses à température élevée)

Dangerous goods that, when offered for transport or transported:

a. are in a liquid phase and at a temperature equal to or greater than 100 °C (212 °F);
b. are in a liquid phase with a flash point equal to or greater than 37.8 °C (100 °F) and that are intentionally heated to a temperature equal to or greater than its flash point; or
c. are in a solid phase and at a temperature equal to or greater than 240 °C (464 °F).

Excess-flow Valve (Limiteur de débit)

A device that closes automatically against the outward flow of fluid in the event that the flow rate through the device reaches a set value.

Executive Director (Directeur exécutif)

Executive Director, Tank Car Safety, Association of American Railroads.

Fatigue Life (Durée de vie en fatigue)

The number of applications of a given stress that can be subjected to a component before failing.

Filling Density (Densité de remplissage)

The percent ratio of the mass of the dangerous goods in a tank to the mass of water that the tank will hold at 15.6 °C (60 °F).

For cryogenic liquids, the percent ratio of the mass of the dangerous goods in the tank to the mass of water that the tank will hold at the design service temperature.

For the purpose of determining the water capacity of the tank, the mass of 1 L of water at 15.6 °C (60 °F) is 0.999007 kg (the mass of 1 US gallon of water is 8.33712 lb).

Grounding (Mise à la terre)

The process of connecting one or more objects to earth in order to minimize differences of electrical potential between objects and the ground.

Hazard Zone (Zone de risque)

One of four levels of hazard, hazard zones A through D, assigned to gases that are toxic by inhalation, as specified in clause 10.5.2. A hazard zone is based on the LC_{50} value for acute inhalation toxicity of gases and vapours.

Independent Inspector (Inspecteur indépendant)

A person, class of persons, test facility, or agency, independent of both Transport Canada and the party being inspected, who is registered with the Director.

Interior Heater System (Système de chauffage interne)

A piping system within a tank that uses a fluid medium to heat the dangerous goods.

Lining or Coating Owner (Propriétaire d'un revêtement/d'une doublure)

The party financially responsible for the maintenance of the lining or coating.

Liquid Dangerous Goods (Marchandises dangereuses liquides)

Dangerous goods that are in liquid or slurry form, including dangerous goods that are under a liquid blanket, at any time during their handling, offering for transport, or transport.

Maintenance (Entretien)

Upkeep or preservation of a container or any of its components, including repairs.

Manufacture (Fabrication)

To assemble a tank car capable of rolling on its own wheels, or produce operational service equipment or any finished ton container or other containers.

Marking (Marquage)

The application by stenciling or stamping of symbols or words required by this standard.

Material Compatible with the Dangerous Goods (Matériau compatible)

A material that does not react physically or chemically with the dangerous goods in a way that under normal conditions of handling or transportation would cause a condition or release of dangerous goods that could endanger public safety, including corrosion, environmental stress cracking, solvation, fusion or chemical or physical reaction with the dangerous goods.

Modification (Modification)

Any deviation in the currently allowed configuration of a tank car from that described in the Certificate of Construction.

NGT (NGT)

National Gas Taper Thread that conforms to United States Federal Standard US-FED-STD-H28, Sections 7A (1984) and 9 (1989).

Nozzle (Manchon)

A sub-assembly of a tank consisting of a pipe or tubular section with or without a welded flange on one end.

NPT (NPT)

A tapered pipe thread that conforms to American National Standard ANSI/ASME B1.20.1-1983 (R2006).

Oil (Pétrole)

Dangerous goods that are:

a. Crude petroleum produced at a well-head in liquid form; or

b. Any other hydrocarbons, except coal and gas, including hydrocarbons that may be extracted or recovered from surface or subsurface deposits, including deposits of oil sand, bitumen, bituminous sand, oil shale and other types of deposits on the surface or subsurface of the seabed or its subsoil.

One Million Mile Fatigue Life (Durée de vie en fatigue d'un million de miles)

Components of a tank car that are designed and built to reach one million miles of service before reaching the fatigue life of the component.

Outage (Creux)

For a tank containing a liquid, the volumetric fraction of the tank in the vapour space, expressed as a percentage.

Padding (Gaz de remplissage)

An inert gas deliberately introduced into the vapour space of a tank in order to make the vapour space gas mixture non-flammable or moisture-free.

ppm (ppm)

Parts per million.

Pressure-relief Device (Dispositif de décharge de pression)

A device that is designed to prevent the rise of internal pressure in excess of a specified value, including a reclosing pressure-relief device, a non-reclosing pressure-relief device, or reclosing and non-reclosing pressure-relief devices in combination.

Pressure Tank Car Tank (Citerne de wagon-citerne sous pression)

A tank car tank conforming to any specification within classes 105, 112, 114 or 120.

Primary Closure (Fermeture primaire)

The first closure after the tank that closes the flow of liquid or vapor.

psi (lb/po^2)

Pound-force per square inch.

Qualification (Qualification)

A careful and critical examination of an item, including a container, based on a written program, to verify that the item conforms to a standard, followed by a representation that the item conforms to that standard.

Refined Petroleum Products (Produits pétroliers raffinés)

Dangerous goods that are:

a. Gasoline-type fuels for use in internal combustion engines;
b. Refined product for use as a component in the blending of gasoline-type fuels referred to in paragraph (a);
c. Middle distillates, including the products commercially known as kerosene, solvents, stove oil, diesel fuel, furnace oil, diesel oil, gas oil, distillate heating oil, engine distillates and Nos. 1, 2, and 3 fuel oils; or
d. Heavy fuel oils, including Nos. 4, 5 and 6 fuel oils, bunker "C" oil, "C" grade oil, residual fuel oil, heavy bunker oil, intermediate and thin bunker fuels and any blend of heavy fuel oils.

Reinforcing Plate (Plaque de renfort)

A metal plate attached directly to a tank by welding, supporting structural components for the purpose of preventing damage to the tank through fatigue, overstressing, denting, puncturing, or tearing.

Release (Rejet)

Includes discharge, emission, explosion, or other escape of dangerous goods, or any component or compound evolving from dangerous goods.

Reliability (Fiabilité)

The quantified ability of a device or structure to be used in a known environment without failure for a specified period.

Repair (Réparation)

Remanufacture or restoration of a container or any of its components to its original function.

Representation (Attestation)

Certification, in writing or in electronic format on a document or by marking the container, that the container conforms to the requirements set out in this standard.

Replacement In-Kind (Remplacement En Nature)

Replacement with the same manufacturer, model, size and capacity.

Safety System (Système de sécurité)

Devices that equip some tank cars, including a tank-head puncture-resistance system, a coupler vertical restraint system, a system used to protect discontinuities including skid protection and protective housings, a thermal protection system, and an insulation system conforming to clause 8.3.19 or to a special provision of Schedule 1, that is used to control pressure or outage.

Secondary Closure (Fermeture secondaire)

The first closure downstream from the primary closure that closes the flow of liquid or vapor if the primary closure would be normally operated.

Service Equipment (Matériel de service)

Devices attached to and forming part of a container and that are necessary for the purpose of filling, loading, unloading, venting, pressure relief, vacuum relief, heating from within the tank, sampling, and measuring. Such devices include vacuum and pressure-relief devices, valves, pressure-relief valves, excess-flow valves, and closures.

Service Equipment Owner (Propriétaire de matériel de service)

The party financially responsible for the maintenance of the service equipment.

Solid Dangerous Goods (Marchandises dangereuses solides)

Dangerous goods which are in solid, granular, crystalline, or powder form during handling, offering for transport, or transport.

Specification (Specification)

A specific designation within a class. For example the designations 111A100W3 and 106A500X are specifications.

Spring-Loaded Check Valve (Mechanically Operated) (Vanne anti-retour à resort (opérée mécaniquement))

A spring loaded check valve located below the pressure plate that can be manually disengaged.

Stamping (Estampage)

A marking method that removes or displaces material leaving a permanent imprint on the surface to be marked.

Stencilling (Marquage au pochoir)

A marking method using paint or decal.

Stub Sill (Longrine centrale courte)

A longitudinal structural member at the ends of a tank car designed to accommodate the coupler and draft gear, and to transmit coupler forces to the tank car tank or outer shell on tank cars without continuous centre sills.

Tank (Citerne)

A closed container consisting of a shell, heads, reinforcing plates, nozzles, reinforcements, or other components welded directly to the shell, excluding external reinforcing pads and internal attachment pads.

Tank Car (Wagon-citerne)

A railway vehicle, other than a hopper car, to which a tank, other than a fuel tank that is required for the purpose of supplying fuel for propulsion of the railway vehicle, is permanently attached.

Tank Car Facility (Installation pour wagons-citernes)

a. An entity that manufactures, repairs, inspects, tests, qualifies, maintains, or modifies a tank car or service equipment including entities that
   i. install, qualify, or repair interior linings and coatings in tank cars when such linings and coatings are intended to protect the tank car tank against the corrosive action of the dangerous goods; or
   ii. remove and replace tank car service equipment or change gaskets, including replacing pressure seals/O-rings on vacuum or pressure-relief devices, eduction pipe removal and replacement or eduction pipe gasket removal and replacement;
b. An entity that only performs one or more of the following operations is not a tank car facility:
   i. Replace in-kind:
      A. Rupture disks in safety vents other than on tank cars used in the handling, offering for transport or transporting of Class 2 gases;
      B. Bottom outlet valve caps;
      C. Hinged manway cover gaskets and/or fill-hole cover gaskets;
      D. Bottom outlet cap gaskets;
      E. Magnetic gauging device rods;

   F. O-rings in gauging device caps;
   G. O-rings in thermometer well housing tubes;
   H. Secondary plugs, chains and flanges external to valves; or
   I. Defective eyebolts on tank cars with hinged manway covers.

ii. Remove and replace eduction pipe caps or eduction pipe blind flange gasket as part of loading/unloading operations or limited maintenance; or

iii. Replace breather vent filters on tank cars used in the handling, offering for transport or transporting of hydrogen peroxide.

Tank Car Owner (Propriétaire du wagon-citerne)

The person identified by the Owner's Mark in the Universal Machine Language Equipment Register (UMLER) database of the AAR.

Tank Car Tank (Citerne de wagon-citerne)

A tank that is intended for attachment to a railway vehicle to form a tank car, but does not include the service equipment.

TC (TC)

Transport Canada.

TDG Act (LTMD)

Transportation of Dangerous Goods Act, 1992, as amended from time to time.

TDG Regulations (RTMD)

Transportation of Dangerous Goods Regulations, as amended from time to time.

Ton Container (Contenant d'une tonne)

A tank that is manufactured to conform to the requirements of:

a. a Class TC 106A or TC 110A tank set out in this standard; or
b. a Class DOT 106A, ICC 106A, ICC 110A, or DOT 110A tank set out in Subpart E of Part 179 of US 49 CFR.

Top Shell (Coque supérieure)

The surface of a tank car tank, excluding the heads and bottom shell.

WP (PF)

The WP (Working Pressure) of a tank is the sum of the static head, padding pressure, and the dangerous goods vapour pressure at the following reference temperatures:

a. 46.1 °C (115 °F) for a non-insulated tank;
b. 43.3 °C (110 °F) for an insulated tank or tank having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance of less than or equal to 10.22 kJ/h·m^{2}·°C (0.5 Btu/h·ft.^{2}·°F) ; or
c. 40.6 °C (105 °F) for an insulated tank when the overall thermal conductance is equal to or less than 1.533 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F).

4 GENERAL REQUIREMENTS

4.1 Application

The requirements set out in this standard apply to containers that are used or may be used in the handling, offering for transport, or transporting of dangerous goods by rail in Canada. These requirements do not apply to containers that are used exclusively for commodities that are not dangerous goods. The containers must conform to:

a. the requirements of the TDG Act, the TDG Regulations, the requirements of this standard, and the requirements of the DOT and the AAR that are specified in this standard, including manufacture, qualification, maintenance, and selection and use; and
b. unless otherwise specified in this standard, the requirements for manufacture set out in the specifications of the containers that were in effect at the time of manufacture and the requirements for maintenance that were in effect during and after manufacture of the containers.

4.2 Continued Use

4.2.1 Qualification and maintenance of tank cars in Canadian service

Subject to clause 4.1, a tank car in Canadian service or ton container that is or may be used in the handling, offering for transport, or transporting of dangerous goods must conform to the requirements for qualification and maintenance set out in section 9 of this standard.

4.3 Equivalency

If the requirements for selection and use set out in this standard permit a tank car or ton container with a given class or specification to contain dangerous goods, a TC, a CTC, an ICC, or a DOT tank car or ton container equivalent to the given class or specification may be used.

4.4 Other Containers

Unless otherwise specified in this standard, TC portable tanks of specifications 11, 44, 51 or 60 conforming to the requirements of CSA B621 or B622 may be used in the handling, offering for transport, or transporting of dangerous goods by rail.

4.5 Classification

Dangerous goods must be classified in accordance with Part 2 of the TDG Regulations and the appropriate shipping name, UN number, classification, division, and packing group, as applicable, must be assigned.

4.6 Schedule 1 and Special Provisions

In addition to the other requirements of this standard, when there is a special provision of Schedule 1 in Appendix E for dangerous goods, that special provision applies to the container and the handling, offering for transport, and transporting of the dangerous goods.

4.7 Schedule 2 and List of Dangerous Goods

In addition to the other requirements of this standard, Schedule 2 in Appendix E must be used when determining the authorized containers and specific conditions applicable to the handling, offering for transport, or transporting of dangerous goods.

4.8 Conflict

If there is a conflict between a special provision of Schedule 1 in Appendix E and other provisions of this standard, the special provision applies. If there is a conflict between any requirement of this standard and a requirement in any of the referenced publications listed in section 2, the requirement of this standard applies.

4.9 Danger to Public Safety

4.9.1 Condition or Release from a Container that Could Endanger Public Safety

A container must be designed, manufactured, qualified, loaded, unloaded, filled, secured, closed, and maintained so that, under normal conditions of transport, including handling and under all conditions of temperature, pressure and vibration that may be expected to occur, no condition or release of dangerous goods that could endanger public safety occurs or may reasonably be expected to occur.

4.9.2 Venting of Containers

Subject to clause 4.9.1, venting of a container, in order to reduce internal pressure that may develop by the evolution of gas or vapour from the dangerous goods contained within the container, is permitted only when permitted for the specific dangerous goods by a special provision in Appendix E or when permitted pressure-relief or pressure-regulating devices are operating as intended.

4.10 Closures

4.10.1 Compliance with Specification

Unless otherwise specified in this standard, a closure on a container must be designed, manufactured, qualified, maintained, secured, and closed so that the closure conforms to the requirements of the specification for the container.

4.10.2 Securing of Closure

Subject to clause 4.9.2, a closure on a container must be designed, manufactured, qualified, maintained, secured, and closed so that, under normal conditions of transport, including handling and all conditions of temperature, pressure and vibration that may be expected to occur, the closure remains secured and closed.

4.10.3 Closures for Manways

4.10.3.1 Automatic Pressure Release

A hinged and bolted manway cover on a tank car must be designed, manufactured, qualified, and maintained in a way that, in the process of opening the manway cover, pressure will be released automatically and no condition or release of dangerous goods that could endanger public safety occurs or may reasonably be expected to occur.

4.10.3.2 Manway below Liquid Level

A tank car used in the handling, offering for transport, or transporting of dangerous goods must not be equipped with a manway located below the liquid level.

4.10.4 Gaskets

Sealants must not be used in the application of gaskets.

4.11 Tank Car Integrity and Continued Use

4.11.1 Tank Car

Subject to clause 4.11.2, a tank car must conform to its original Certificate of Construction or subsequent approvals by the Executive Director. A tank car is not in conformance if it has defects such as cracks or fractures in the tank car tank, external shell, continuous center sill or draft sill such that the tank car is no longer capable of withstanding the minimum loads, stresses and fatigue requirements specified by the AAR *Specifications for Tank Cars* and *Design, Fabrication, and Construction of Freight Cars* publications.

4.11.2 Excepted Insulation

A tank car that has deteriorated insulation or jackets is not considered in non-conformance when an insulation system is not mandatory by the tank car specification and the tank car is equipped with safety relief devices, as required, for non-insulated tank cars.

4.12 Tank Car Cleaning Prior to Conducting Work

A tank car containing dangerous goods must be cleaned prior to conducting any work that may create a hazard due to the presence of the commodity.

5 QUALITY MANAGEMENT SYSTEM

5.1 Scope

For the purpose of this section, a quality management system means all of the planned and systematic actions taken by a tank car facility to provide adequate confidence that a tank car, service equipment, lining or coating conforms to the requirements set out in this standard and the TDG Regulations, including the requirements for design, manufacture, qualification, maintenance of tank cars and handling of dangerous goods.

5.2 Application

Each tank car facility must have a quality management system that includes all of the elements and processes specified in clause 5.4.

5.3 General Requirements

The quality management system must be developed and established in accordance with the requirements of a standard or series of standards and must be registered, approved, or certified by an organization independent of both Transport Canada and the tank car facility. The standard or series of standards must be internationally recognized as being capable of meeting or exceeding the requirements of this section.

5.4 Specific Elements and Processes of the Quality Management System

5.4.1 Management Commitment

The management of the tank car facility must appoint a member of management who, irrespective of other responsibilities, shall have the authority and responsibility for overseeing the quality management system of the tank car facility, including:

a. ensuring the quality management system is established and maintained;

b. reporting to management on the performance of the quality management system; and

c. promoting awareness of the importance of the requirements of this standard and the TDG Regulations throughout the tank car facility.

5.4.2 Planning

A planning process for the products and services provided by the tank car facility for transforming the requirements of this standard and the TDG Regulations into quality objectives for each product or service must be established and documented. The planning process must include a means for determining:

a. processes and documentation and the level of detail required;

b. verification and validation activities;

c. records that are necessary to ensure compliance to the requirements of this standard and the Regulations; and

d. if the tank car facility has the ability to meet the determined requirements.

5.4.3 Human Resources

A human resources management process must be established and documented. This process must:

a. determine competency needs for personnel affecting quality;

b. provide effective training to ensure competency of personnel;

c. create and maintain records of education, training, qualification, and certification, as required;

d. create and maintain awareness and importance of the quality management system to all employees; and

e. assign quality responsibilities to personnel on the basis of their meeting the respective competency needs.

5.4.4 Purchasing

A purchasing control process must be set out to ensure purchased products and services conform to the requirements of this standard and the TDG Regulations. The purchasing control process must include procedures for the evaluation and selection of suppliers.

5.4.5 Product Realisation

An operations control process for the products and services provided by the tank car facility must be established and documented. The operation control process must require:

a. the provision of information to personnel that specifies the quality of the product or service;

b. the provision of written procedures as determined by the quality planning process;

c. the availability and good order of equipment used for the realisation of products and services;

d. the availability and accuracy of monitoring and measuring devices;

e. the provision of written instructions to employees;

f. the provision of a description of the manufacturing, repair, inspection, testing, and qualification or maintenance program including the acceptance criteria, so that the characteristics of the tank car, service equipment, lining or coating and the elements to inspect, examine, and test can be identified;

g. the provision of procedures for non-destructive inspections for qualification authorized and evaluated by the owner to ensure the inspection and test technique employed, taking into account the accessibility of the area, has the capability of detecting a defect of the minimum rejectable size;

h. a system for the maintenance of records, inspections, tests, and the interpretation of inspection and test results; and

i. the qualification of personnel involved in performing any non-destructive inspections and tests in accordance with Appendix T of the AAR *Specifications for Tank Cars* publication.

5.4.6 Measurement, Analysis, and Improvement

A measurement, analysis, and improvement process must be established that allows a tank car facility to verify the compliance of the products and services provided to the requirements of this standard and the TDG Regulations, to determine and address the cause of any non-compliance, and if necessary to improve the quality management system. The measurement, analysis, and improvement processes shall address:

a. the measurement and monitoring of processes;

b. the evaluation and monitoring of products and services;

c. the release and delivery of products and services, including post-delivery activities and maintenance of records;

d. the control of non-compliant products and services;

e. the determination and elimination of the causes of any non-compliance;

f. periodic internal audits to determine if the quality management system complies with the requirements of this standard and the TDG Regulations and has been effectively implemented and maintained; and

g. the calibration of inspection and test equipment.

5.4.7 Other Elements

Procedures must be established to ensure:

a. that the applicable drawings, design calculations, specifications, and instructions are used in the manufacturing, repair, inspection, testing, and qualification or maintenance;

b. that incoming parts and materials are properly identified and segregated when received and in storage; and

c. that any maintenance or modification of a tank car involving welding is documented in the form of a detailed procedure.

6 REGISTRATION, APPROVALS AND CERTIFICATION

6.1 Registration of Tank Car Facilities Located in Canada

6.1.1 Registration

A tank car facility located in Canada must be registered by the Director. A registered tank car facility must only perform the tank car, service equipment and lining and coating functions authorized by the Director.

6.1.2 Certificate of Registration

A facility is registered upon the issuance, by the Director, of a Certificate of Registration, which will be valid until the expiration date indicated on the certificate or its revocation for cause. The registered facility must perform the functions authorized by the Certificate of Registration at the location stipulated on the Certificate of Registration unless the certificate authorizes the facility to conduct these activities elsewhere.

A copy of the facility's current Certificate of Registration must be available for review upon request by a Transport Canada inspector.

6.1.3 Application for Registration

Application for registration must be submitted to the Director and, at a minimum, must include the following information:

a. name, street address, mailing address of the facility applying for registration, and proof of business registration (e.g., certificate of incorporation, letters patent);

b. detailed description of the facility, equipment, personnel (including the certificate(s) of the NDT level III individual(s)), quality management system and of the functions that will be performed; and

c. evidence that the facility meets the certification requirements in Appendix B of *AAR Specifications for Tank Cars* publication, for the functions for which registration is requested.

6.1.4 Registration and Compliance

The Director must register the facility if the Director is satisfied that the facility is capable of consistently complying with the applicable requirements of this standard.

6.1.5 Revocation for Cause

The Director may revoke the Certificate of Registration of the facility if the Director is satisfied that the facility is not capable of or is not complying with the applicable requirements of this standard.

6.2 Procedure for Securing Approval of Tank Cars

6.2.1 Application

Before a tank car enters service after manufacture or re-enters service after modification, approval must be obtained from the Executive Director. To obtain approval for the design, manufacture, modification, or weld repair of a specification tank car, an application together with detailed drawings must be submitted in accordance with the requirements set out in par. 1.4 of the AAR *Specifications for Tank Cars* publication. The Executive Director must issue approvals or rejections of applications.

6.2.2 Compliance

If the tank car is in compliance with the requirements of this standard, the application must be approved by the Executive Director.

6.3 Certificate of Construction

6.3.1 Manufacturer Responsible for Certificate of Construction

Before a tank car is used for the handling, offering for transport, or transporting of dangerous goods, the manufacturer of the tank car must provide the owner and the Executive Director each with a copy of the Certificate of Construction in the form specified in par. 1.4 of the *AAR Specifications for Tank Cars* publication.

6.3.2 Manufacture of Tank Cars in Series

If more than one tank car or tank car tank are manufactured successively, are identical in all details of design, manufacture, and materials to one another, and are submitted as one application in accordance with the procedure for approval under clause 6.2, only one Certificate of Construction covering each series or subset of a series of such tank cars or tank car tanks is required.

6.4 Service Equipment Approval

If the AAR *Specifications for Tank Cars* publication specifies that approval is required for service equipment of a tank car, the tank car must not be used for the handling, offering for transport, or transporting of dangerous goods by rail unless the service equipment has been approved by the Executive Director.

6.5 Registration by Manufacturer or Independent Inspector of Ton Containers

6.5.1 Manufacture of Ton Container

Before a ton container is manufactured and marked to a TC specification, the manufacturer's facility and the design of the ton container must be registered with the Director. A manufacturing facility located in Canada must be registered with the Director.

6.5.2 Inspection at Manufacturer's Facilities

An independent inspector must be registered with the Director for the specific purpose of inspections at the manufacturer's registered facilities.

6.5.3 Application for Registration

An application for registration must be submitted to the Director, and at a minimum, must include the following information:

a. name of the applicant, name of a contact person, street address and mailing address of the applicant;

b. in the case of a ton container manufacturer:

    i. the name and location of the manufacturing facility and a description of the manufacturing process;

- ii. the design information of the ton container, including service equipment;
- iii. the name and address of the independent inspector; and
- iv. a copy of a sample certificate of construction.

c. in the case of an independent inspector:

- i. the inspection functions that the applicant intends to perform;
- ii. a statement of the qualifications of the inspection staff based on their experience and training; and
- iii. a copy of a sample certificate of inspector's report.

6.5.4 Registration and Compliance

The Director must register the ton container manufacturer or independent inspector if the Director is satisfied that the manufacturer or inspector is capable of complying with the applicable requirements of this standard.

6.5.5 Revocation for Cause

The Director may revoke the Certificate of Registration of the ton container manufacturer or independent inspector if the Director is satisfied that the manufacturer or inspector is not capable of or is not complying with the applicable requirements of this standard.

6.5.6 Ownership Transfer of Ton Container

At the time of initial ownership transfer of a TC Class 106A or TC Class 110A ton container, the manufacturer must provide the owner with a copy of the Certificate of Construction and a copy of the Certificate of Inspector's Report certifying that the tank and its service equipment conform to the requirements of the specification in accordance with the requirements set out in clause 8.5.18.

6.6 Registration of Ton Container Periodic Retest Facilities

6.6.1 Registration

A ton container periodic retest and inspection facility located in Canada must be registered with the Director.

A registered facility must only perform the hydrostatic pressure test, the air-pressure test, or the visual inspection test set out in clauses 9.9.2.1, 9.9.2.2, 9.9.2.3, and 9.9.2.8 as authorized by the Director.

6.6.2 Application for Registration by a Test Facility

An application for registration must be submitted to the Director and, at a minimum, must include the following information:

a. name of the applicant, name of a contact person, street address, and mailing address of the applicant;

b. name and location of the test facility;

c. description of the equipment, inspection and test procedures;

d. statement of the qualifications of the inspection staff based on their experience and training; and

e. copy of a test report.

6.6.3 Registration and Compliance

The Director must register the test facility if the Director is satisfied that the facility is capable of complying with the applicable requirements of this standard.

6.6.4 Revocation for Cause

The Director may revoke the registration of the test facility if the Director is satisfied that the facility is not capable of or is not complying with the applicable requirements of this standard.

7 MARKINGS

7.1 Scope

In addition to any other marking requirements set out in this standard, the marking requirements of this section apply.

7.2 Tank Car Stencilled Markings

7.2.1 AAR Requirements

A tank car must be marked in accordance with the requirements set out in Appendix C of the AAR *Specifications for Tank Cars* publication with the exception, subject to clause 8.6.23, that the requirements of par. C2.3.1.3 and C5.0 relative to commodity markings do not apply.

7.2.2 Puncture Resistance System

A tank car that requires and that is equipped with a tank-head puncture-resistance system must have the letter "S" substituted for the letter "A" in the specification marking.

7.2.3 Jacketed Thermal Protection

A tank car that requires a tank-head puncture-resistance system and a thermal protection system and that is equipped with a tank-head puncture-resistance system and a thermal protection system with a metal jacket must have the letter "J" substituted for the letter "A" or "S" in the specification marking.

7.2.4 Non-Jacketed Thermal Protection

A tank car that requires a tank-head puncture-resistance system and a thermal protection system and that is equipped with a tank-head puncture-resistance system and a thermal protection system without a metal jacket must have the letter "T" substituted for the letter "A" or "S" in the specification marking.

7.2.5 Interim Tank Cars

A tank car that was manufactured before the coming into force of this standard to meet the requirements of clauses 10.5.1.2 b. or 10.5.1.2 c. or special provisions, 62, 64, 65, 80, 81, 82 or 83 may have the letter "I" substituted for the letter "W" in the specification marking until the first tank qualification event after the coming into force of this standard.

7.2.6 Class 117 Tank Cars

7.2.6.1 Class 117 Retrofit Tank Cars

A Class 111 tank car that was modified to meet the Class 117 retrofit requirements of clause 8.3.25.2 must have class number 117 substituted for 111 and the letter "R" substituted for "A", "S", or "J" in the specification marking.

7.2.6.2 Class 117 Performance Tank Cars

A tank car that meets the Class 117 performance requirements of clause 8.3.25.2 must have the letter "P" substituted for "A", "S", "J", "T" or "R" in the specification marking.

7.3 Identification Plates

7.3.1 Alternative to Permanent Markings

As an alternative to the permanent markings required by a tank car specification, including clauses 8.3.20, 8.4.21, and 8.6.22, a tank car may be equipped with tank identification plates conforming to clauses 7.3.1.1 to 7.3.1.3. Tank cars manufactured after January 15, 2015 must conform to clauses 7.3.1.1 to 7.3.1.3.

7.3.1.1 The tank manufacturer must install two identical permanent identification plates, one located on both inboard surfaces of the body bolsters of the tank car. One identification plate must be installed on the right side (AR) of the tank car, and the other must be installed on the back end left side (BL) body bolster webs so that each plate is readily accessible for inspection. The plates must be at least 2.38 mm (3/32 in.) thick and manufactured from corrosion resistant metal. When the tank jacket (flashing) covers the body bolster web and identification plates, additional identical plates must be installed on the AR and BL corners of the tank in a visible location.

7.3.1.2 Each plate must be stamped, embossed, or otherwise marked by an equally durable method in letters 4.76 mm (3/16 in.) high with the following information (parenthetical abbreviations may be used), and the AAR form reference is to the applicable provisions of the AAR *Specifications for Tank Cars* publication:

a. *Tank Manufacturer (Tank MFG):* Full name of the car builder as shown on the certificate of construction (AAR form 4-2).
b. *Tank Manufacturer's Serial Number (SERIAL NO)*: For the specific car.
c. *AAR Number (AAR NO):* The AAR number from line 3 of AAR Form 4-2.
d. *Tank Specification (SPECIFICATION):* The specification to which the tank was built from line 7 of AAR form 4-2.
e. *Tank Shell Material/Head Material (SHELL MATL/HEAD MATL):* ASTM or AAR specification of the material used in the construction of the tank shell and heads from lines 15 and 16 of AAR Form 4-2. For Class 113,115, AAR-204W, and AAR-206W, the materials used in the construction of the outer tank shell and heads must be listed. Only list the alloy (e.g., 5154) for aluminum tanks and the type (e.g., 304L or 316L) for stainless steel tanks.
f. *Insulation Material (INSULATION MATL):* Generic names of the first and second layer of any thermal protection/insulation material applied.
g. *Insulation Thickness (INSULATION THICKNESS)*: In millimetres but may include inches. [ex: 00 mm (00 in.)]
h. *Underframe/Stub Sill Type (UF/SS DESIGN):* The design from Line 32 of AAR Form 4-2.
i. *Date of Manufacture (DATE OF MFR):* The month and year of tank manufacture. If the underframe has a different built date than the tank, show both dates.

7.3.1.3 When a modification to the tank changes any of the information shown in clause 7.3.1.2, the car owner or the tank car facility making the modification must install an additional variable identification plate on the tank in accordance with clause 7.3.1.1 showing the following information:

a. *AAR Number (AAR NO):* The AAR number from line 3 of AAR Form 4-2 for the alteration or conversion.
b. All items of clause 7.3.1.2 that were modified, followed by the month and year of modification.

7.3.1.4 The identification plates and their attachment to the tank car must be capable of withstanding a fire at a temperature of 426.7 °C (800 °F).

7.4 Qualification and Conversion Markings

7.4.1 Qualification Date and Due Date

When a tank car passes the required qualification for an item referred to in clause 9.3, the tank car facility must mark on the tank car the date on which the tank car was qualified and the due date for the next qualification in conformance with the requirements set out in Appendix C of the AAR *Specifications for Tank Cars* publication.

7.5 Delayed Installation

When a pressure-relief device is qualified within six months of installation on a tank car and is protected from deterioration during that period of time, the qualification date of the pressure-relief device marked on the tank car must be either the installation date of the device on the tank car or the qualification date of the pressure-relief device. A pressure-relief device shall not be installed on a tank car after 6 months from the qualification date without first being qualified again.

8 MANUFACTURE AND MODIFICATION OF TANK CARS AND TON CONTAINERS FOR TRANSPORT OF DANGEROUS GOODS

8.1 General

8.1.1 Scope

The requirements set out in clauses 8.1 and 8.2 are general and basically apply to all tank cars and ton containers used in Canada for the handling, offering for transport, or transporting of dangerous goods. The requirements in clauses 8.3 to 8.6 apply to the design and manufacture of TC specification tank cars and ton containers. Specific requirements may have broader scope when referenced in other sections of this standard.

8.1.2 Responsibility of Manufacturer

8.1.2.1 Responsibility of Tank Car Manufacturers

Tank car manufacturers are responsible for obtaining the approval of the Executive Director for the design and manufacture of tank cars and for ensuring that the tank cars conform to all the applicable requirements of this standard.

8.1.2.2 Responsibility of Ton Container Manufacturers

TC specification ton container manufacturers are responsible for obtaining the approval of the Director for the design and manufacture of ton containers and for ensuring that the ton containers conform to all the applicable requirements of this standard.

8.1.3 Responsibility of Owner

8.1.3.1 Responsibility of Tank Car Owner

Tank car owners are responsible for obtaining the approval of the Executive Director for the modification of tank cars and for ensuring that the tank cars conform to all the applicable requirements of this standard.

8.1.3.2 Responsibility of Ton Container Owner

TC specification ton container owners are responsible for obtaining the approval of the Director for the modification of ton containers and for ensuring that the ton containers conform to all the applicable requirements of this standard.

8.1.4 Marking and Certification

If this section requires a tank car or ton container to be marked with a TC Specification, the manufacturer of the tank car or ton container is responsible for ensuring compliance with that marking requirement.

8.2 General Technical and Safety System Requirements

8.2.1 Interior Heater Systems

8.2.1.1 Hydrostatic Test

Interior heater systems are authorized on Class 111 and 115 tank car tanks. Each interior heater system must be hydrostatically tested at the time of manufacture at not less than 1379 kPa (200 psi) and hold the pressure for 10 min without showing evidence of yielding or leakage.

8.2.2 Minimum Burst Pressure

The minimum burst pressure of a Class 111, 113, 115, 117 or a pressure tank car tank must be the minimum burst pressure defined in the following clauses:

Tank Car Class	Defining Clause
111	8.3.25
113	8.6.24
115	8.4.23
117	8.3.25
105, 112, 114, 120	8.3.22

8.2.3 Protection for Service Equipment

8.2.3.1 Bottom Shell Service Equipment Connections

Service equipment connections located in the bottom shell must be designed, manufactured and protected in accordance with paragraphs E8.0 and E9.0, of the AAR *Specifications for Tank Cars* publication.

8.2.3.2 Protective Housing for Pressure Tank Cars

A Class 105, 112, 114, or 120 tank car must be equipped with a protective housing that conforms to the following requirements:

a. Except as provided in clause 8.3.23, a protective housing of cast, forged or fabricated materials must be bolted to the manway cover with not less than twenty 19.1 mm (3/4 in.) nominal diameter studs or bolts;
b. The total ultimate shear strength of the studs or bolts attaching the protective housing to the manway cover must be equal to or less than 70% of the total ultimate shear strength of the studs or bolts attaching the manway cover to the manway nozzle;
c. The protective housing must have steel sidewalls equal to or greater than 19.1 mm (3/4 in.) in thickness and must be equipped with a metal cover equal to or greater than 6.35 mm (1/4 in.) in thickness that can be securely closed;
d. The protective housing cover must have a suitable stop to prevent the cover from striking the loading and unloading connections and must be hinged; and
e. Openings in the wall of the protective housing must be equipped with screw plugs or other closures.

8.2.3.3 Protective Housing for Class 113 Tank Cars

8.2.3.3.1 Each valve, gauge, closure, and pressure-relief device, with the exception of secondary relief valves for the protection of isolated piping, must be enclosed within a protective housing.

8.2.3.3.2 The protective housing must be adequate to protect the enclosed service equipment from direct solar radiation, mud, sand, adverse environmental exposure, and mechanical damage encountered during the normal handling or transport of the tank car.

8.2.3.3.3 The protective housing must be designed to:

a. provide reasonable access to the enclosed service equipment for operation, inspection, and maintenance; and

b. prevent vapour concentration build up to a dangerous level inside the housing in the event of valve leakage or pressure-relief device operation.

8.2.3.3.4 All equipment within the protective housing must be operable by personnel wearing heavy gloves and must incorporate provisions for locks or seals.

8.2.3.3.5 A protective housing and its cover must be manufactured of metal equal to or greater than 3.02 mm (0.119 in.) in thickness.

8.2.3.4 Protective Housing for Dangerous Goods in Packing Groups I and II and Class 117 Tank Cars

8.2.3.4.1 A Class 111 tank car built after October 1, 2015 and used in the transportation of dangerous goods in Packing Groups I or II or, subject to clauses 8.2.3.4.2 and 8.2.3.4.3, a Class 117 tank car must have a protective housing that conforms to the following.

The protective structure must be as tall as the tallest fitting involved and must provide protection for those fittings, without overstressing the tank shell and nozzles, when subjected to forces of 1/2W in the vertical downward direction, 1W horizontal in the longitudinal direction, and 1/2W horizontal in the lateral direction, where:

a. W is defined as the designed gross rail load of the tank car, less trucks;
b. The forces are applied separately and uniformly over the projected plane of the protective structure perpendicular to the direction of the force;
c. For horizontal loads, the projected plane extends from the top of the tank to the top of the protective structure;
d. In the case of multiple nozzles:
   i. The forces are applied uniformly over their combined projected area if the reinforcement zones of the nozzle, as defined in par. E2.3.1, of the AAR *Specifications for Tank Cars* publication, have a positive overlap; and
   ii. If there is no overlap of the reinforcement zones, each nozzle must be protected so that it can withstand the applied loads independent of the other nozzles;
e. Calculations must use the minimum specified tensile strength of the material for the tank, nozzle(s), unprotected service equipment, and protective device (where applicable); and
f. Stresses must not exceed the critical buckling stress of the assembly under consideration.

*8.2.3.4.1.1*The design stresses must not exceed the minimum specified tensile stress for the tank, nozzle, and protective housing, provided that the critical buckling stresses are not exceeded.

*8.2.3.4.1.2*The protective structure must not reduce the pressure relief device flow capacity below the minimum required.

*8.2.3.4.1.3*The protective structure must provide a means of drainage with a minimum flow area equivalent to six holes, each having a diameter of 25.4 mm (1 in.).

*8.2.3.4.1.4*The strength of the attachment of the protective structure to its base structure must not exceed 70% of the attachment strength of the base structure to its base structure. For example, if the protective structure is attached to the nozzle, the strength of the attachment of the protective structure to the nozzle must not exceed 70% of the strength of the attachment of the nozzle to the tank.

*8.2.3.4.1.5*Individual fittings may be unprotected if there is no loss of lading when subjected to the design loads in clause 8.2.3.4.1.1. If unprotected fittings are used in conjunction with a protective structure, the design loads are shared in proportion to the projected area of the protective structure and the fittings.

*8.2.3.4.1.6*Discontinuity protection is not required for manway covers that have internal or external shear rings designed to resist the horizontal loads defined in clause 8.2.3.4.1.1.

*8.2.3.4.1.7*No discontinuity protection is required for internal pressure relief devices, cover plates, blind flanges, or plugs.

8.2.3.4.2 Despite Clause 8.2.3.4.1, the protective housing for a specification TC117R or retrofitted TC117P tank car may meet the following requirements:

i. has a thickness equal to or greater than 12.7 mm (1/2 in.);

ii. is made of a material having a tensile strength not less than 448 MPa (65 000 psi);

iii. is as tall as the tallest valve or fitting involved and the height of a valve or fitting within the protective housing must be kept to the minimum compatible with their proper operation;

iv. may not reduce the flow capacity of the pressure relief device below the minimum required;

v. provide a means of drainage with a minimum flow area equivalent to six holes, each having a diameter of 25.4 mm (1 in.);

vi. when connected to the nozzle or fitting cover plate and subject to a horizontal force applied perpendicular to and uniformly over the projected plane of the protective housing, the tensile connection strength of any protective housing shall be designed to be:

   A. no greater than 70% of the nozzle to tank tensile connection strength;

   B. no greater than 70% of the cover plate to nozzle connection strength; and,

   C. no less than either 40% of the nozzle to tank tensile connection strength or the shear strength of twenty 12.7 mm (1/2 in.) nominal diameter bolts.

vii. The pressure relief device is located as follows:

A. It is located inside the protective housing, unless space does not permit and in that case, only one pressure relief device can be located outside of a protective housing;

B. the highest point of any pressure relief device that is located outside of a protective housing must not be more than 305 mm (12 in.) above the tank jacket; and,

C. the highest point on the closure of any unused pressure relief device nozzle must not be more than 152 mm (6 in.) above the tank jacket.

8.2.3.4.3 As an alternative to the requirements of clause 8.2.3.4.2 for specification TC117R or retrofitted TC117P tank cars, the tank car may be equipped with a system that prevents the release of contents from any top fitting under accident conditions where any top fitting may be sheared off.

8.2.3.5 Protective Housing for Dangerous Goods Toxic by Inhalation Tank Cars

Each tank car manufactured after January 15, 2015 for the transportation of dangerous goods toxic by inhalation must, in addition to the requirements prescribed in clause 8.2.3.2, enclose the service equipment within a protective housing and cover.

i. Each tank car must be equipped with a protection system for service equipment and nozzle capable of sustaining, without failure, a rollover accident at a speed of 14.5 km/h (9 mph), in which the rolling protective housing strikes a stationary surface assumed to be flat, level and rigid and the speed is determined as a linear velocity, measured at the geometric center of the loaded tank car as a transverse vector. Failure is deemed to occur when the deformed protective housing contacts any of the service equipment or when the lading retention capability is compromised.

ii. As an alternative to the tank car protective system for service equipment in paragraph i., the tank car may be equipped with a system that prevents the release of product from any of the top fittings in the case of an accident where any top fitting would be sheared off, and only internal, spring-loaded check valve devices designed to remain closed during transportation are authorized. The tank nozzle must meet the performance standard in paragraph i.

8.2.4 Tank Car Capacity

A tank car must not be manufactured or modified to exceed a capacity of 130 596 L (34 500 US gallons).

8.2.5 Coupler Vertical Restraint System

8.2.5.1 Performance Standard

Each tank car must be equipped with couplers capable of sustaining, without disengagement or material failure, vertical loads equal to or greater than 889.6 kN (200 000 lbf) applied in upward and downward directions in combination with horizontal coupler compressive loads of 8.896 kN (2000 lbf), when coupled to railway vehicles which may or may not be equipped with couplers having this vertical restraint capability.

8.2.5.2 Test Verification

Compliance with the requirements of clause 8.2.5.1 must be verified by testing of a representative prototype of the coupler vertical restraint system in accordance with clause 8.2.5.3.

8.2.5.3 Coupler Vertical Restraint Test

A coupler vertical restraint system must be tested under the following conditions:

a. The test coupler must be tested with another coupler or simulated coupler having only frictional vertical force resistance at the mating interface; or having the capabilities described in clause 8.2.5.1;

b. The testing apparatus must simulate the vertical coupler performance at the mating interface and must not interfere with coupler failure or otherwise inhibit failure resulting from force applications and reactions; and

c. The test must be conducted as follows:

    i. A vertical downward load of not less than 889.6 kN (200 000 lbf) must be applied continuously for not less than 5 min to the test coupler head simultaneously with the application of a nominal horizontal coupler compressive load of 8.896 kN (2000 lbf);

    ii. The procedures set out in clause 8.2.5.3.c.i must be repeated with a vertical upward load equal to or greater than 889.6 kN (200 000 lbf); and

    iii. For each load combination specified in the two preceding clauses, not less than three consecutive successful tests must be performed. A test is successful if a vertical disengagement or material failure does not occur during the application of any of the loads specified in this clause.

8.2.6 Pressure-relief Devices

8.2.6.1 Performance Requirements

Except for Class 113 and AAR 204W tank cars, tank car tanks must be equipped with one or more pressure-relief devices with sufficient flow capacity so that pressure buildup in the tank car tank, in fire conditions set out in Appendix A of the AAR *Specifications for Tank Cars* publication, does not exceed the flow rating pressure of the pressure-relief device.

8.2.6.2 Material

The pressure-relief device must be made of material compatible with the dangerous goods.

8.2.6.3 Settings for Reclosing Pressure-relief Devices

A reclosing pressure-relief device must have a start-to-discharge pressure:

a. greater than the WP;

b. equal to or less than 33% of the minimum tank car tank burst pressure; and

c. equal to or greater than 517 kPa (75 psi).

If a pressure-relief device has a start-to-discharge pressure that is higher than the tank specification test pressure, the tank must be tested at the pressure-relief device start-to-discharge pressure for tank cars built after the coming into force of this standard.

8.2.6.4 Flow Rating

The flow capacity and rating of pressure-relief devices must conform to the following requirements:

a. Each reclosing or non-reclosing pressure-relief device must conform to the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication;

b. The manufacturer of a reclosing or non-reclosing pressure-relief device must verify conformity of any pressure-relief device to the requirement of Appendix A of the AAR *Specifications for Tank Cars* publication by testing a representative prototype of each pressure-relief device design; and

c. The nominal flow rating pressure must be:

   i. for tank car tanks having a minimum burst pressure greater than 3447 kPa (500 psi), 110% of the start-to-discharge pressure; and

   ii. for tank car tanks having a minimum burst pressure less than or equal to 3447 kPa (500 psi), not less than 110% and not greater than 130% of the start-to-discharge pressure.

8.2.6.5 Tolerances

Reclosing pressure-relief devices must conform to the following requirements:

a. For new and re-built devices, the tolerance for the start-to-discharge pressure is ±21 kPa (±3 psi) for devices with a nominal start-to-discharge pressure equal to or less than 689 kPa (100 psi) and ±3% for devices with a nominal start-to-discharge pressure greater than 689 kPa (100 psi);

b. The vapour-tight pressure must be equal to or greater than 80% of the start-to-discharge pressure; and

c. For in-service devices, the tolerance for the start-to-discharge pressure is -5%/+10% provided the start-to-discharge pressure is equal to or less than the WP, otherwise the allowable tolerance -3%/+10%.

8.2.6.6 Non-reclosing Pressure-relief Devices

A non-reclosing pressure-relief device must:

a. incorporate a rupture disc designed to burst at 33% of the tank car tank minimum burst pressure;

b. have an approach channel and a discharge channel that do not reduce the minimum flow capacity of the pressure-relief device;

c. be designed to not be interchangeable with other fittings installed on the tank car;

d. have a structure that encloses and clamps the rupture disc in position in order to prevent, when properly applied, any distortion or damage to the rupture disc; and

e. have a cover designed to direct any discharge of the dangerous goods downward and with a means of preventing misplacement.

8.2.6.7 Rupture Disc

A rupture disc must:

a. be compatible with the dangerous goods;

b. be manufactured in accordance with the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication;

c. not have an opening; and

d. have an actual burst pressure within +0 to -15% of the burst pressure marked on the disc.

8.2.6.8 Pressure-relief devices in combination

a. If a non-reclosing pressure-relief device is used in series with a reclosing pressure-relief device, the reclosing pressure-relief device must be located outboard of the non-reclosing pressure-relief device;

b. If a breaking pin device is used in combination with a reclosing pressure-relief device, the breaking pin device must be designed to fail at the pressure set out in clause 8.2.6.3 and the reclosing pressure-relief device must be set to start discharging at a pressure no greater than 96% of that pressure;

c. If a rupture disc is used in combination with a reclosing pressure-relief device:

   i. the rupture disc must be designed to burst at the pressure set out in clause 8.2.6.3;

   ii. the reclosing pressure-relief device must be set to start to discharge at a pressure no greater than 96% of the pressure set out in clause 8.2.6.3;

   iii. a needle valve, trycock, or telltale indicator must be installed to allow detection of any accumulation of pressure between the rupture disc and the reclosing pressure-relief device; and

   iv. the vapour-tight pressure and the tolerance of the start-to-discharge pressure of the reclosing pressure-relief device must be based on the discharge setting of that device.

8.2.6.9 Location of Pressure-relief Devices

A pressure-relief device must communicate with the vapour space above the dangerous goods and be located as near as practicable on the longitudinal centreline and centre of the tank.

8.2.6.10 Marking of Pressure-relief Devices

A pressure-relief device must be permanently marked in accordance with the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication.

8.2.7 Thermal Protection Systems

8.2.7.1 Performance Standard

If a thermal protection system is specified by this standard, the system must be capable of preventing the release of any dangerous goods from a tank car filled to its authorized loading limit, except release through the pressure-relief device, when subjected to the following conditions:

a. A pool-fire for 100 min; and
b. A torch-fire for 30 min.

8.2.7.2 System Survivability and Thermal Analysis

Compliance with the requirements set out in clause 8.2.7.1 must be verified first by testing the system for survivability in accordance with Appendix D and be verified then by analyzing the behaviour of the tank car and dangerous goods when subjected to fire conditions set out in clause 8.2.7.1, and such analysis must take into account the following parameters acting in combination:

a. the fire effects on and heat flux through tank discontinuities, protective housings, underframes, metal jackets, insulation, and thermal protection;
b. an upright and a 120° roll over orientation along the longitudinal axis of the tank car;
c. a pool-fire which completely engulfs the tank car with fire temperatures equal to or greater than 815.6 °C (1500 °F) and a torch-fire temperature equal to or greater than 1204.4 °C (2200 °F);
d. tank external surface emissivity being equal to or greater than 0.9;
e. a discharge coefficient of the pressure-relief device of 0.8 for vapour and 0.6 for liquids or the use of other values, provided the use of such other values is supported by actual test data;
f. the heat transfer properties of the thermal protection or insulation material as a function of temperature, as established by actual test data;
g. the dangerous goods being at an initial temperature of 46.1 °C (115 °F) or, if lower, the highest temperature at which the dangerous goods can exist in the liquid state within the tank;
h. the maximum volumetric filling limit specified for the dangerous goods excluding any modified filling limit applicable during winter; and
i. the composition and thermal properties of the dangerous goods.

8.2.7.3 Thermal Protection Systems for New Class 117 Tank Cars

For Class 117 tank cars built after the date this standard comes into force, the thermal protection system must include at least a 12.7 mm (1/2 in.) thick ceramic fibre blanket.

8.2.7.4 Record retention

A complete record of each analysis must be made and retained by the owner of the tank car.

8.2.8 Tank-head Puncture-resistance Systems

8.2.8.1 Performance Standard
If a tank-head puncture-resistance system is specified, it must be capable of sustaining the coupler-to-tank-head impacts specified in Appendix C, at relative tank car speeds of 29 km/h (18 mph) without any loss of dangerous goods when:

a. the mass of the impacting car is equal to or greater than 119 295 kg (263 000 lb);

b. the impacted tank car is coupled to one or more stationary backup cars that have a total mass equal to or greater than 217 724 kg (480 000 lb) and the hand brake is applied on the last backup car; and

c. the internal pressure of the impacted tank car is equal to or greater than 698 kPa (100 psi).

8.2.8.2 Verification
Conformance with the requirements of clause 8.2.8.1 must be verified by full-scale testing in accordance with Appendix C or, as an alternative, compliance with the requirements of clause 8.2.8.1 is considered to be achieved by installing a full-head protection shield or a full tank-head jacket on each end of the tank car that conforms to the following requirements:

a. The shield or jacket must be equal to or greater than 12.7 mm (1/2 in.) in thickness, shaped to the contour of the tank-head and made from steel that has a minimum specified tensile strength equal to or greater than 379 MPa (55 000 psi);
b. The design and test requirements of the shield or jacket must conform to the impact test requirements set out in par. 5.3, of the AAR *Specifications for Tank Cars* publication; and
c. The workmanship for the shield or jacket must conform to the requirements set out in Chapter 5 of the AAR *Design, Fabrication, and Construction of Freight Cars* publication.

8.2.8.3 Deeming Provision

Unless otherwise specified in this standard, a Class 105 tank car that has a tank test pressure equal to or greater than 3447 kPa (500 psi) is deemed to conform to the tank-head puncture-resistance system requirements of clause 8.2.8.

8.3 General Requirements Applicable to TC Class 111 Tank Car Tanks, TC Class 117 Tank Car Tanks and TC Pressure Tank Car Tanks

8.3.1 General

A TC Specification 111, TC Specification 117 or a TC pressure tank car tank must conform to the requirements set out in this clause, except where otherwise provided by the individual specification.

8.3.2 Pressure Tank Car Tanks

A pressure tank car tank must:

a. be fusion-welded with formed convex outward heads;

b. be circular in cross section;

c. be provided with a manway nozzle on top;

d. have a manway cover where all valves, measuring devices and sampling devices are mounted;

e. have a protective housing conforming to clause 8.2.3.2;

f. only have openings in the tank that are permitted in the specification; and

g. have normalized shell and heads when made from carbon steel. Heads must be normalized after forming unless the Executive Director specifically approved otherwise.

8.3.3 TC Specification 111 and 117 Tank Car Tanks

A TC Specification 111 or 117 tank car tank must:

a. be fusion-welded with formed convex outward heads;

b. be circular in cross section; and

c. have at least one manway.

8.3.4 Welding

Welders must comply with and welding procedures must conform to the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.3.5 Metal Plate

8.3.5.1 Carbon and low alloy steel plate used must conform to Appendix M of the AAR *Specifications for Tank Cars* publication.

8.3.5.2 Aluminum Alloy Plate:

a. alloys must be used in one of the following tempers: 0, H112, or H32, except for alloy 5083 which must be used in the 0 temper only;

b. filler material alloy conforming to Unified Numbering System UNS A95556 must not be used; and

c. the plate must conform to one of the specifications and corresponding minimum tensile strength set out in the following table:

Specification	Minimum Tensile Strength MPa (psi)
ASTM B209M or B209, Alloy 5052	172 (25 000)
ASTM B209M or B209, Alloy 5083	262 (38 000)
ASTM B209M or B209, Alloy 5086	241 (35 000)
ASTM B209M or B209, Alloy 5154	207 (30 000)

Specification	Minimum Tensile Strength MPa (psi)
ASTM B209M or B209, Alloy 5254	207 (30 000)
ASTM B209M or B209, Alloy 5454	214 (31 000)
ASTM B209M or B209, Alloy 5652	172 (25 000)

8.3.5.3 High Alloy Steel Plate:

a. the plate must conform to one of the specifications and corresponding minimum tensile strength set out in the following table; and

Specification	Minimum Tensile Strength MPa (psi)
ASTM A240/A240M, Type 304L	483 (70 000)
ASTM A240/A240M, Type 316L	483 (70 000)
ASTM A240/A240M, Type 304	517 (75 000)
ASTM A240/A240M, Type 316	517 (75 000)

b. the plate must be tested in accordance with the procedure indicated for the plate material and, after sensitizing treatment, must exhibit a corrosion rate in testing no greater than the corresponding value indicated in the following table:

ASTM A262 Test Procedure	Material	Corrosion Rate mm (in.) per month
Practice B	Types 304, 304L, 316 and 316L	0.1016 (0.0040)
Practice C	Type 304L	0.0508 (0.0020)

8.3.6 Minimum Thickness

8.3.6.1 The minimum thickness, in millimetres (inches), measured after forming of the tank shell and of 2:1 ellipsoidal heads must be the greater of:

a. the minimum plate thickness specified in clauses 8.3.22 or 8.3.25; and

b. the plate thickness calculated using the following formula:

$$t = \frac{Pd}{2SE}$$

where:

t = minimum thickness of plate, in mm (in.), after forming

P = minimum burst pressure, in MPa (psi)

d = inside diameter, in mm (in.)

S = minimum tensile strength of plate material, in MPa (psi), as specified in clause 8.3.5

E = 0.9, a factor representing the efficiency of welded joints, except that for welds that are 100% radiographed, $E = 1.0$

8.3.6.2 If cladding material having minimum tensile strength properties equal to or greater than the base plate is used, the cladding may be considered to be a part of the base plate when determining thickness. However, if cladding material that has lower tensile strength is used, the base plate alone must conform to the thickness requirement.

8.3.7 Tank Heads

8.3.7.1 External tank heads must have the form of an ellipsoid of revolution in which the major axis is equal to the diameter of the shell and the minor axis is equal to one-half the major axis.

8.3.7.2 Internal compartment tank heads on a Specification 111 or 117 tank car tank must either have the form of a 2:1 ellipsoid or be flanged and dished to a thickness, as set out in clause 8.3.6. A flanged and dished internal head must have:

a. a main inside radius equal to or less than 3048 mm (120 in.); and

b. an inside knuckle radius equal to or greater than:

   i. 95.3 mm (3.75 in.) for steel, alloy steel, or nickel tanks; and

   ii. 127 mm (5 in.) for aluminum alloy tanks.

8.3.7.3 Subject to clause 8.3.7.4, each tank head made from steel which is required to be "fine grain" or "fine grain practice" by the material specification and which is hot-formed at a temperature equal to or greater than 926.7 °C (1700 °F) must be normalized after forming by heating the steel to a temperature between 843.3 °C and 926.7 °C (1550 °F and 1700 °F), holding at that temperature for at least the greater of 30 min and 1 hour per 25.4 mm (1 in.) of thickness, and then by cooling in air.

8.3.7.4 If the material specification requires quenching and tempering, the treatment requirements set out in that specification must be used instead of the one set out in clause 8.3.7.3.

8.3.8 Compartmented Specification 111 and 117 Tank Car Tanks

8.3.8.1 If a tank is divided into compartments by inserting internal heads:

a. the internal heads must be inserted in conformance with the requirements set out in par. E6.0 of the AAR *Specifications for Tank Cars* publication and must conform to the requirements specified in clause 8.3.25;

b. voids between compartment heads must be provided with at least one tapped drain hole at their lowest point and a tapped hole at the top of the tank and the tapped holes must not be less than ¾ NPT and not greater than 1½ NPT in size; and

c. the top and bottom holes must be closed with solid NPT plugs.

8.3.8.2 If a tank is divided into compartments by manufacturing each compartment as a separate tank:

a. the separate tanks must be joined together by a cylinder made of plate having a thickness equal to or greater than that required for the tank shell;

b. the cylinder must

   i. be applied to the outside surface of the tank head flanges;

   ii. fit the straight flange portion of the compartment tank head tightly;

   iii. contact the head flange for a distance of at least two times the plate thickness or a minimum of 25.4 mm (1 in.), whichever is greater; and

   iv. the cylinder must be joined to the head flange by a full fillet weld;

c. the distance from head seam to cylinder must be equal to or greater than 38.1 mm (1.5 in.) or three times the plate thickness, whichever is greater;

d. voids created by the space between heads of tanks joined together to form a compartment tank must be provided with a tapped drain hole at their lowest point and a tapped hole at the top of the tank and the tapped holes must not be less than ¾ NPT and not greater than 1½ NPT in size; and

e. the top and bottom holes must be closed with solid NPT plugs.

8.3.9 Attachments

8.3.9.1 Tanks must have reinforcing pads between external brackets and tank if the attachment welds to tank are equal to or greater than 152 linear mm (6 linear in.) of 6.35 mm (1/4 in.) fillet or equivalent weld per bracket or bracket leg. Reinforcing pads are not required for the following attachments:

a. thin attachments, such as exterior heater coils and drip ledges;

b. cast bottom outlet skids that are attached to tanks over a broad area;

c. full-girth attachments, such as compartmented tank attachment rings and tank stiffening rings, that are continuously attached to tanks; or

d. tank bottom reinforcing plates or bars and attachments welded thereto.

8.3.9.2 Reinforcing pads are required for:

a. any air brake equipment support attachments; and

b. any other bracket or attachment, regardless of weld length, if they could cause damage to the tank either through fatigue, over-stressing, denting or puncturing in the event of an accident.

8.3.9.3 Reinforcing pads must:

a. be equal to or greater than 6.35 mm (1/4 in.) in thickness;
b. not exceed the thickness of the tank shell to which they are welded, by more than 15%;
c. have each corner rounded to a radius equal to or greater than 25.4 mm (1 in.);
d. be attached to the tank by continuous fillet welds, except for venting provisions; and
e. a pad-to-tank fillet weld leg size not exceeding the tank shell thickness.

8.3.9.4 The distance between a bracket and the edge of the reinforcing pad to which it is attached must not be less than three times the thickness of the pad.

8.3.9.5 The ultimate shear strength of the bracket-to-reinforcing pad weld must be equal to or less than 85% of the ultimate shear strength of the reinforcing pad-to-tank weld.

8.3.10 Bottom Outlets

8.3.10.1 The bottom outlet must not extend from the tank shell more than that authorized in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.3.10.2 Each bottom outlet reducer and secondary closure and their attachments must be secured by, at least, a 9.53 mm (3/8 in.) chain or its equivalent, except that outlet closure plugs may be secured by a 6.35 mm (1/4 in.) chain or its equivalent;

8.3.10.3 If the bottom outlet closure is of the combination cap-and-valve type, the pipe connection to the valve must be closed by a plug, cap, or quick-coupling device.

8.3.10.4 The bottom outlet must include only the valve, reducer, and closures that are necessary for the attachment to handling equipment.

8.3.10.5 Each bottom outlet must be provided with a liquid-tight closure at its lower end.

8.3.10.6 On tank cars with continuous centre sills, a ball valve may be welded to the outside bottom of the tank or mounted on a pad or nozzle that is attached to the outside bottom of the tank using a tongue-and-groove or male-and-female flange attachment. The breakage groove or its equivalent must not extend below the bottom flange of the centre sill.

8.3.10.7 On tank cars without continuous centre sills, a ball valve may be welded to the outside bottom of the tank or mounted on a pad using a tongue-and-groove or male-and-female flange attachment. The pad must be attached to the outside bottom of the tank.

8.3.10.8 The pad referred to in clauses 8.3.10.6 and 8.3.10.7, must have a maximum thickness of 63.5 mm (2.5 in.) measured on the longitudinal centreline of the tank.

8.3.10.9 The valve operating mechanism must include a means of locking the valve in the closed position during transport.

In the case of a TC Class 114, 117 or 120 tank car equipped with a bottom outlet valve, the valve handle – unless stowed separately – must be designed to bend, break free or be protected on impact without the valve opening or is designed so that all of the handle is located within the bottom discontinuity protective structure.

8.3.10.10 To provide for the attachment of handling connections, the bottom of the main portion of the outlet nozzle or valve body of exterior valves, or any fixed attachment thereto, must be provided with:

a. a bolted flange closure arrangement including a 1 in. NPT pipe plug or including an auxiliary valve with a threaded closure;

b. a threaded cap closure arrangement including a 1 in. NPT pipe plug or including an auxiliary valve with a threaded closure;

c. a quick-coupling device that has a threaded plug closure equal to or greater than 1 NPT or has a threaded cap closure with a 1 in. NPT pipe plug. A minimum 1 in. nominal size auxiliary test valve with a threaded closure may be substituted for the 1 in. NPT pipe plug. If the threaded cap closure does not have a pipe plug or integral auxiliary test valve, a 1 in. NPT pipe plug must be installed in the outlet nozzle above the closure; or

d. a two-piece quick-coupling device using a clamped dust cap must include an in-line auxiliary valve either integral with the quick-coupling device or located between the primary bottom outlet valve and the quick-coupling device. The quick-coupling device closure dust cap or outlet nozzle must be fitted with a 1 in. NPT closure.

8.3.10.11 If the outlet nozzle extends 152 mm (6 in.) or more from the shell of the tank, the outlet nozzle must conform to the following requirements:

a. A breakage "V" groove must be cut, not cast, into the upper part of the outlet nozzle at a point immediately below the lowest part of the valve to a depth that leaves the thickness of the nozzle wall at the root of the "V" equal to or less than 6.35 mm (1/4 in.);

b. If the outlet nozzle on interior valves or the valve body on exterior valves is steam-jacketed, the breakage groove or its equivalent must be below the steam chamber but above the bottom of the centre sill for tank cars with continuous center sills;

c. If the outlet nozzle is not a single piece or if exterior valves are applied, provision must be made for the equivalent of the breakage groove;

d. On tank cars without continuous centre sills, the breakage groove or its equivalent must be equal to or less than 381 mm (15 in.) below the tank shell; and

e. On tank cars with continuous centre sills, the breakage groove or its equivalent must be above the bottom of the centre sill.

8.3.10.12 The thickness of the flange on the outlet nozzle or the valve body of exterior valves must be sufficient to:

a. prevent distortion of the valve or valve seat by any change in contour of the shell resulting from the expansion of the dangerous goods or from the expansion due to other causes; and

b. ensure that accidental breakage of the outlet nozzle will occur at or below the breakage "V" groove or its equivalent.

8.3.10.13 The valve must have no wings or stem projecting below the breakage "V" groove or its equivalent. The valve and valve seat must be readily accessible or removable for repairs, including grinding.

8.3.11 Bottom Washouts

8.3.11.1 The bottom washout must not extend from the tank shell more than that authorized in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.3.11.2 If the washout nozzle extends 152 mm (6 in.) or more from the tank shell, the washout nozzle must conform to the following requirements:

a. A breakage "V" groove must be cut, not cast, in the upper part of the washout nozzle at a point immediately below the lowest part of the inside closure seat or plug to a depth that leaves the thickness of the nozzle wall at the root of the "V" equal to or less than 6.35 mm (1/4 in.);

b. If the washout nozzle is not a single piece, provision must be made for the equivalent of the breakage groove;

c. The thickness of the washout nozzle must be sufficient to ensure that accidental breakage will occur at or below the breakage "V" groove or its equivalent;

d. On tank cars without continuous centre sills, the breakage "V" groove or its equivalent must be equal to or less than 381 mm (15 in.) below the tank shell; and

e. On tank cars with continuous centre sills, the breakage "V" groove or its equivalent must be above the bottom of the centre sill.

8.3.11.3 The closure of the washout nozzle must be equipped with a 3/4 in. NPT solid plug. The plug must be attached to its nozzle by, at least, a 6.35 mm (1/4 in.) chain.

8.3.12 Manway Nozzles and Covers on a TC Pressure Tank Car Tank

8.3.12.1 A manway nozzle must be manufactured of forged or rolled steel for steel tanks or of aluminum alloy for aluminum tanks and must have an access opening with an inside diameter equal to or greater than 457 mm (18 in.) or at least 356 X 457 mm (14 X 18 in.) obround or oval. The nozzle must be welded to the tank and the opening reinforced in conformance with the requirements set out in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.3.12.2 The manway cover must be attached to the manway nozzle by bolts or studs not entering the tank.

8.3.13 Manway Flanges, Safety Device Flanges, Bottom Outlet Nozzle Flanges, Bottom Washout Nozzle Flanges, and Other Attachments and Openings on a Specification 111 and 117 Tank Car Tank

8.3.13.1 The attachments must be fusion-welded to the tank and reinforced in conformance with the requirements set out in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.3.13.2 The opening in the manway must have a diameter equal to or greater than 406 mm (16 in.), except that lined manways must have a diameter equal to or greater than 457 mm (18 in.) before lining.

8.3.13.3 The manway flange must be made of cast, forged, or fabricated metal that is weldable to the metal of the tank shell.

8.3.13.4 Openings for manways or for other service equipment must be reinforced.

8.3.13.5 For TC Specification 117 tank cars, all top shell service equipment - except for a hinged and bolted manway – is mounted on the cover plate and enclosed in a protective housing that meets the requirements set out in clause 8.2.3.4.

8.3.14 Post-weld Heat Treatment

8.3.14.1 After welding is completed, steel tanks and all attachments welded thereto must be post-weld heat-treated as a unit in conformance with the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.3.14.2 For aluminum tanks, post-weld heat treatment is prohibited.

8.3.14.3 Tanks and welded attachments fabricated from high alloy steel materials do not require post-weld heat treatment.

8.3.15 Manway Covers on a Specification 111 or 117 Tank Car Tank

Manway covers must conform to the requirements set out in par. E3.3 of the AAR *Specifications for Tank Cars* publication.

8.3.16 Venting Valves, Loading and Unloading Valves, Gauging, Measuring, and Sampling Devices on a TC Pressure Tank Car Tank

8.3.16.1 The venting valves and loading and unloading valves must be made of metal compatible with the dangerous goods and must withstand the tank test pressure without leakage.

8.3.16.2 The venting valves and loading and unloading valves must be bolted directly to the seatings on the manway cover, except as provided in clause 8.3.23.

8.3.16.3 The outlets of venting valves and loading and unloading valves must be closed with screw plugs or other closures fastened to prevent misplacement.

8.3.16.4 The interior pipes of the loading and unloading valves must be anchored.

8.3.16.5 Gauging devices, sampling devices, and thermometer wells must:

a. be made of metal compatible with the dangerous goods and withstand the tank test pressure without leakage;

b. the interior pipe of the thermometer well must be anchored in a manner to prevent breakage; and

c. the thermometer well must be closed by a cap attached near the manway cover. Other arrangements that permit testing the thermometer well for leaks without complete removal of the closure may be used.

8.3.16.6 A sump or siphon bowl, welded or pressed into the shell, must conform to the following requirements:

a. The sump or siphon bowl must be made of cast, forged, or fabricated metal that is weldable to the metal of the tank shell;

b. If the sump or siphon bowl is pressed into the bottom of the tank shell, the wall thickness of the pressed section must be equal to or greater than that specified for the shell;

c. The section of a tank of circular cross section to which the sump or siphon bowl is attached need not conform to the out-of-roundness requirement set out in par. W13.5 of the AAR *Specifications for Tank Cars* publication; and

d. Any portion of the sump or siphon bowl not forming a part of a cylinder of revolution must have walls of such thickness and be so reinforced that the stresses in the walls caused by internal pressure are equal to or less than the circumferential stress caused by the same internal pressure in the wall of a tank of circular cross section designed in conformance with the requirements set out in clause 8.3.6. The wall thickness must be equal to or greater than that specified in clause 8.3.22.

8.3.17 Gauging Devices, Top Loading and Unloading Devices, Venting, and Air Inlet Devices for a Specification 111 or 117 Tank Car Tank

8.3.17.1 Each device must be of a design that will prevent interchange with any other service equipment.

8.3.17.2 Unloading pipes must be securely anchored within the tank.

8.3.17.3 When the device is equipped with valves or fittings to permit the loading and unloading, each device, including valves or fittings, must be provided with a protective housing.

8.3.17.4 Protective housings are not required when plug or ball-type valves are used and their operating handles are removed.

8.3.17.5 Provision must be made for closing the pipe connections of valves.

8.3.17.6 A protective housing is not required for a vacuum-relief valve.

8.3.17.7 When a tank car with a hinged manway cover is equipped with a fixed internal gauging bar, an outage indicator visible through the manway opening must be provided.

8.3.17.8 If loading devices are applied to permit tank loading with the cover closed, a telltale pipe may be used. The telltale pipe must be capable of indicating that the required outage is provided. The pipe must be equipped with a control valve equal to or less than ¼ NPT mounted outside the tank and enclosed within a protective housing.

8.3.17.9 Other devices may be used instead of the outage indicator or telltale pipe referred to in clauses 8.3.17.7 or 8.3.17.8.

8.3.17.10 A sump or siphon bowl, welded or pressed into the shell, must conform to the following requirements:

a. The sump or siphon bowl must be made of cast, forged, or fabricated metal that is weldable to the metal of the tank shell;

b. If the sump or siphon bowl is pressed into the bottom of the tank shell, the wall thickness of the pressed section must be equal to or greater than that specified for the shell;

c. The section of a tank of circular cross section to which the sump or siphon bowl is attached need not conform to the out-of-roundness requirement set out in par. W13.5 of the AAR *Specifications for Tank Cars* publication; and

d. Any portion of the sump or siphon bowl not forming a part of a cylinder of revolution must have walls of such thickness and be so reinforced that the stresses in the walls caused by internal pressure are equal to or less than the circumferential stress caused by the same internal pressure in the wall of a tank of circular cross-section designed in conformance with the requirements set out in clause 8.3.6. The wall thickness must be equal to or greater than that specified in clause 8.3.25.

8.3.17.11 If top loading, discharge, venting or air inlet devices are installed at a location remote from the manway and with exposed piping:

a. shut-off valves must be applied directly to reinforcing pads or nozzles at their communication through the tank shell and must be enclosed in a protective housing with provision for a seal;

b. the piping must include breakage grooves and suitable bracing;

c. relief valves must be applied to liquid lines for protection in case dangerous goods are trapped; and

d. provision must be made to ensure closure of the shut-off valves during transport.

8.3.17.12 Protective housing, if required, must have a cover and sidewalls no less than 3.02 mm (0.119 in.) in thickness.

8.3.18 Plugs for Openings

8.3.18.1 Each plug must be solid, with NPT threads, and must be of a length that will screw at least six threads inside the face of the fitting or tank.

8.3.18.2 Each plug, if inserted from the outside of a Specification 111A tank head, must have the letter "S" equal to or greater than 9.53 mm (3/8 in.) in height stamped or cast on the outside surface. The letter "S" indicates that the plug is solid.

8.3.19 Insulation

Specification 105 and 120 tank cars require insulation. When insulation is required, the insulation must conform to the following requirements:

a. The tank shell and head must be insulated;
b. The insulation must be covered with a metal jacket that has a thickness equal to or greater than 3.04 mm (11 gauge) and must be flashed around all openings so as to be weather tight;
c. The exterior surface of a carbon steel tank and the inside surface of a carbon steel jacket must be given a coating to protect against corrosion;
d. If exterior heaters are attached to the tank, the thickness of the insulation over each heater element may be reduced to one-half that required for the shell; and
e. The insulation must be of sufficient thickness so that the overall thermal conductance at 15.6 °C (60 °F) is equal to or less than 4.599 $\text{kJ/h}\cdot\text{m}^{2}\cdot{}^{\circ}\text{C}$ (0.225 $\text{Btu/h}\cdot\text{ft.}^{2}\cdot{}^{\circ}\text{F}$) for specification 111 and 117 tank car tanks, or 1.533 $\text{kJ/h}\cdot\text{m}^{2}\cdot{}^{\circ}\text{C}$ (0.075 $\text{Btu/h}\cdot\text{ft.}^{2}\cdot{}^{\circ}\text{F}$) for pressure tank car tanks.

8.3.20 Permanent Markings

Subject to clause 7.3, a tank car tank must conform to the following marking requirements:

8.3.20.1 Each tank must have permanent markings, including:

a. tank car tank specification;
b. month and year of the original tank test;
c. tank manufacturer's identifying mark;
d. tank car assembler's identifying mark, if different from the tank manufacturer; and
e. material specification of the tank wall, including separate material specifications for the shell and heads if they are different and the cladding material specification if the tank is internally clad.

8.3.20.2 The permanent markings must be stamped in letters and figures equal to or greater than 9.53 mm (3/8 in.) in height into the metal on the external surface and near the centre of both heads.

8.3.20.3 In the case of a TC Specification 111 or 117 tank car tank, the last numeral of the Specification number may be omitted from the marking; for example, a

"TC 111A100W" marking for a specification 111A100W2 tank car. The following is an example of the required markings:

TC 105A100W
12-01
ABC
Assembler/Assembleur DEF
Head/Tête ASTM A 516-70
Shell/Coque TC128 B
Revêtement ASTM A 240-304 clad

8.3.21 Pressure Testing of Tanks

8.3.21.1 Each tank must be tested by:

a. filling the tank to the top of the manway nozzle with water or other liquid having similar viscosity, at a temperature equal to or less than 37.8 °C (100 °F) during the test; and

b. applying a pressure equal to or greater than the tank car tank test pressure for at least 10 minutes.

8.3.21.2 Tanks must be tested before insulation is applied.

8.3.21.3 Tanks must be tested before any lining or coating is applied.

8.3.21.4 Repairs must be made in conformance with the requirements set out in Appendix R of the AAR *Specifications for Tank Cars* publication.

8.3.21.5 Testing of exterior heaters is not required.

8.3.21.6 For a successful pressure test there must be no evidence of tank yielding or leakage, either liquid or gas, during the 10 minutes hold period.

8.3.22 Additional Requirements for TC Pressure Tank Car Tank Specifications

The requirements of column 2 to 8 of this table apply to the corresponding specification indicated in the first column:

Individual Specification Minimum Requirements

TC Specification	Minimum Plate Thickness mm (in.)	Tank Burst Pressure kPa (psi)	Tank Test Pressure kPa (psi)	Minimum Manway Cover Thickness mm (in.)	Bottom Outlet	Bottom Washout	Specific Requirement
105A100ALW	15.9 (5/8)	3447 (500)	689 (100)	63.5 (2½)	No	No	8.3.22.1

Individual Specification Minimum Requirements

TC Specification	Minimum Plate Thickness mm (in.)	Tank Burst Pressure kPa (psi)	Tank Test Pressure kPa (psi)	Minimum Manway Cover Thickness mm (in.)	Bottom Outlet	Bottom Washout	Specific Requirement
105A200ALW	15.9 (5/8)	3447 (500)	1379 (200)	63.5 (2½)	No	No	8.3.22.1
105A300ALW	15.9 (5/8)	5171 (750)	2068 (300)	66.7 (2 5/8)	No	No	8.3.22.1
105A100W	14.3 (9/16)	3447 (500)	689 (100)	57.2 (2¼)	No	No	8.3.22.2
105A200W	14.3 (9/16)	3447 (500)	1379 (200)	57.2 (2¼)	No	No	8.3.22.2
105A300W	17.5 (11/16)	5171 (750)	2068 (300)	57.2 (2¼)	No	No	8.3.22.2 8.3.22.3 8.3.22.4
105A400W	17.5 (11/16)	6894 (1000)	2758 (400)	57.2 (2¼)	No	No	8.3.22.2 8.3.22.3 8.3.22.4
105A500W	17.5 (11/16)	8618 (1250)	3447 (500)	57.2 (2¼)	No	No	8.3.22.2 8.3.22.3
105A600W	17.5 (11/16)	10342 (1500)	4137 (600)	57.2 (2¼)	No	No	8.3.22.2 8.3.22.3
112A200W	14.3 (9/16)	3447 (500)	1379 (200)	57.2 (2¼)	No	No	8.3.22.2 8.3.22.5
112A340W	17.5 (11/16)	5860 (850)	2344 (340)	57.2 (2¼)	No	No	8.3.22.2 8.3.22.3
112A400W	17.5 (11/16)	6894 (1000)	2758 (400)	57.2 (2¼)	No	No	8.3.22.2 8.3.22.3
112A500W	17.5 (11/16)	8618 (1250)	3447 (500)	57.2 (2¼)	No	No	8.3.22.2 8.3.22.3

Individual Specification Minimum Requirements

TC Specification	Minimum Plate Thickness mm (in.)	Tank Burst Pressure kPa (psi)	Tank Test Pressure kPa (psi)	Minimum Manway Cover Thickness mm (in.)	Bottom Outlet	Bottom Washout	Specific Requirement
114A340W	17.5 (11/16)	5860 (850)	2344 (340)	As Per M-1002 E.3.1	Optional	Optional	8.3.10.9 8.3.22.2 8.3.22.3 8.3.22.6
114A400W	17.5 (11/16)	6894 (1000)	2758 (400)	As Per M-1002 E.3.1	Optional	Optional	8.3.10.9 8.3.22.2 8.3.22.3 8.3.22.6
120A200ALW	15.9 5/8	3447 (500)	1379 (200)	63.5 (2½)	Optional	Optional	8.3.10.9 8.3.22.1
120A100W	14.3 (9/16)	3447 (500)	689 (100)	57.2 (2¼)	Optional	Optional	8.3.10.9 8.3.22.2
120A200W	14.3 (9/16)	3447 (500)	1379 (200)	57.2 (2¼)	Optional	Optional	8.3.10.9 8.3.22.2
120A300W	17.5 (11/16)	5171 (750)	2068 (300)	57.2 (2¼)	Optional	Optional	8.3.10.9 8.3.22.2 8.3.22.3
120A400W	17.5 (11/16)	6894 (1000)	2758 (400)	57.2 (2¼)	Optional	Optional	8.3.10.9 8.3.22.2 8.3.22.3
120A500W	17.5 (11/16)	8618 (1250)	3447 (500)	57.2 (2¼)	Optional	Optional	8.3.10.9 8.3.22.2 8.3.22.3

8.3.22.1 If material other than aluminum alloys are used, the thickness must be equal to or greater than 57.2 mm (2.25 in.).

8.3.22.2 The steel of the shell and heads must be in the normalized condition.

8.3.22.3 If high-alloy steel of 483 to 558 MPa (70 000 to 81 000 psi) minimum tensile strength is used, the plate thickness must be equal to or greater than 15.9 mm

(5/8 in.), and if high-alloy steel of 558 MPa (81 000 psi) minimum tensile strength is used, the plate thickness must be equal to or greater than 14.3 mm (9/16 in.).

After the coming into force of this standard, any new tank car construction using carbon steel of 483 to 558 MPa (70 000 to 81 000 psi) minimum tensile strength must have a plate thickness equal to or greater than 16.7 mm (21/32 in.) and any new tank car construction using carbon steel of 558 MPa (81 000 psi) minimum tensile strength must have a plate thickness equal to or greater than 14.3 mm (9/16 in.).

8.3.22.4 If the characteristics of the dangerous goods require the use of nickel or nickel alloy, the thickness must be equal to or greater than 50.8 mm (2 in.).

8.3.22.5 For a tank car tank having an inside diameter equal to or less than 2210 mm (87 in.), the plate thickness must be equal to or greater than 12.7 mm (1/2 in.).

8.3.22.6 The requirements set out in clause 8.3.23.2 and par. E3.1 of the AAR *Specifications for Tank Cars* publication apply.

8.3.23 Additional Requirements for TC Specification 114 and 120 Pressure Tank Car Tanks

8.3.23.1 Service equipment and openings

Service equipment need not be mounted on the manway cover and one opening may be provided in each head for use in purging the tank interior.

8.3.23.2 Manway Cover

A protective housing is not required if no service equipment is mounted on the manway cover.

8.3.23.3 Venting Valves, Loading and Unloading Valves, and Measuring and Sampling Devices

Venting valves, loading and unloading valves, and measuring and sampling devices must conform to the following requirements:

a. if used, they must be attached to a nozzle or nozzles on the tank shell or heads;

b. they must be grouped in one location and, except as provided in clause 8.3.12, must be equipped with a protective housing with cover or must be recessed into the tank shell with cover. An additional set of venting valves, loading and unloading valves, and measuring and sampling devices grouped in another location is permitted;

c. the protective housing with cover, if used, must have steel sidewalls of a thickness equal to or greater than 19.1 mm (3/4 in.) and a metal cover that can be securely closed and has a thickness equal to or greater than 6.35 mm (1/4 in.); and

d. for service equipment recessed into the tank shell with cover, the cover must be made of metal having a thickness equal to or greater than 6.35 mm (1/4 in.).

8.3.23.4 Pressure-relief Devices and Pressure Regulators

Pressure-relief devices and pressure regulators must conform to both of the following requirements:

a. they must be located on top of the tank near the centre of the car on a nozzle, mounting plate, or recessed in the shell. Any bolt or stud, if used, must not enter the tank; and

b. metal guards must be provided to protect pressure-relief devices and pressure regulators from damage.

8.3.24 Enhanced Class 111 Tank Cars

8.3.24.1 A Class 111 tank car is an enhanced Class 111 tank car with a jacket if the following conditions are met:

a. all the top shell service equipment is enclosed in a protective housing that meets the requirements set out in 8.2.3.4.1;

b. the tank shell and heads are made of carbon or low-alloy steel plate, in the normalized condition, that is AAR TC128 Grade B steel or ASTM A516 Grade 70 steel, or high alloy steel plate;

c. tank heads made of AAR TC128 Grade B or ASTM A516 Grade 70 steel are normalized after forming;

d. in the case of a tank shell and heads made of AAR TC128 Grade B steel, the shell and heads have a thickness equal to or greater than 11.1 mm (7/16 in.);

e. in the case of a tank shell and heads made of ASTM A516 Grade 70 steel, the shell and heads have a thickness equal to or greater than 12.7 mm (1/2 in.);

f. in the case of a tank shell and heads made of high alloy steel, the shell and heads must be at least 11.1 mm (7/16 in.) thick and be equipped with 12.7 mm (1/2 in.) thick jacket heads at a minimum.

g. the tank car is equipped with a jacket that
   i. is made of ASTM A1011 steel, or steel of an equivalent standard,
   ii. has a thickness equal to or greater than 3 mm (11 gauge), and
   iii. is weather-resistant;

h. the tank is insulated or fitted with a thermal protection blanket;

i. the tank car is equipped with one or more reclosing pressure relief devices, each with a start-to-discharge pressure that is equal to or greater than 517 kPa (75 psi);

j. the tank car is equipped at each end with a head shield that
   i. is made with structural or pressure vessel steel plate that has a thickness equal to or greater than 12.7 mm (1/2 in.), and
   ii. covers at least the lower half of the tank head; and

k. in the case of a tank car manufactured after the date this standard comes into force and is equipped with a bottom outlet valve, the valve handle – unless stowed separately – is designed to bend, break free or be protected on impact without the valve opening or is designed so that all of the handle is located within the bottom discontinuity protective structure.

8.3.24.2 A Class 111 tank car is an enhanced Class 111 tank car without a jacket if the following conditions are met:

a. the tank car meets the conditions set out in clauses 8.3.24.1 a. to c. and i. to k.;

b. in the case of a tank shell and heads made of AAR TC128 Grade B steel, the shell and heads have a thickness equal to or greater than 12.7 mm (1/2 in.); and

c. in the case of a shell and heads made of ASTM A516 Grade 70 steel, the shell and heads have a thickness equal to or greater than 14.3 mm (9/16 in.).

d. in the case of a tank shell and heads made of high alloy steel, the shell and heads have a thickness equal to or greater than 12.7 mm (1/2 in.) and be equipped with at least 12.7 mm (1/2 in.) thick half-head shields applied on the lower half of the head.

8.3.25 Additional Requirements for TC 111 and TC 117 Tank Car Tank Specifications

The requirements of column 2 to 7 of this table apply to the corresponding specification indicated in the first column:

Individual Specification Minimum Requirements						
TC Specification	**Minimum Plate Thickness mm (in.)**	**Tank Burst Pressure kPa (psi)**	**Tank Test Pressure kPa (psi)**	**Bottom Outlet**	**Bottom Washout**	**Specific Requirement**
111A60ALW1	12.5 (1/2)	1654 (240)	414 (60)	Optional	Optional	8.3.25.5.1
111A60ALW2	12.5 (1/2)	1654 (240)	414 (60)	No	Optional	—
111A100ALW1	15.8 (5/8)	3447 (500)	689 (100)	Optional	Optional	8.3.25.5.1
111A100ALW2	15.8 (5/8)	3447 (500)	689 (100)	No	Optional	—
111A100W1	11.1 (7/16)	3447 (500)	689 (100)	Optional	Optional	8.3.25.5.1
111A100W2	11.1 (7/16)	3447 (500)	689 (100)	No	Optional	—
111A100W5	11.1 (7/16)	3447 (500)	689 (100)	No	No	8.3.25.3 8.3.25.5.2

Individual Specification Minimum Requirements

TC Specification	Minimum Plate Thickness mm (in.)	Tank Burst Pressure kPa (psi)	Tank Test Pressure kPa (psi)	Bottom Outlet	Bottom Washout	Specific Requirement
111A100W6	11.1 (7/16)	3447 (500)	689 (100)	Optional	Optional	8.3.25.4 8.3.25.5.1 8.3.25.5.3
111A100W7	11.1 (7/16)	3447 (500)	689 (100)	No	No	8.3.25.3 8.3.25.5.3
117A100W1	14.3 (9/16)	3447 (500)	689 (100)	Optional	Optional	8.3.25.5.1 8.3.10.9
117A100W5	14.3 (9/16)	3447 (500)	689 (100)	No	No	8.3.25.3 8.3.25.5.2
117A100W6	14.3 (9/16)	3447 (500)	689 (100)	Optional	Optional	8.3.25. 8.3.10.9 8.3.25.5.3

8.3.25.1 TC Specification 111 and 117 Suffixes

a. A TC Specification 111 tank car tank listed in the table of clause 8.3.25 must conform to the following requirements:

  i. An "ALW" TC Specification tank car tank must be manufactured from aluminum alloy plate;

  ii. A "W1" through "W5" TC Specification tank car tank must be manufactured from carbon steel plate;

  iii. A "W6" and "W7" TC Specification tank car tank must be manufactured from high alloy steel plate; and

  iv. A "W5" TC Specification tank car tank must have an interior lining that conforms to the requirements set out in clause 8.3.25.3.

b. A TC Specification 117 tank car tank listed in the table of clause 8.3.25 must conform to the following requirements:

  i. A "W1" through "W5" TC Specification tank car tank must be manufactured from AAR TC128B normalized steel plate.

  ii. A "W5" TC Specification tank car tank must have an interior lining that conforms to the requirements set out in clause 8.3.25.3.

   iii. A "W6" TC Specification tank car tank must be manufactured from high alloy steel plate; and

8.3.25.2 Additional Requirements for Class TC 117 Tank Cars

a. The tank car must be equipped with a thermal protection system that meets the requirements of clause 8.2.7.
b. The tank car must be equipped with a reclosing pressure device that meets the requirements of clause 8.2.6.
c. TC Class 117 tank cars, other than specification TC117P, must be equipped with a jacket that:
   i. is manufactured using ASTM A1011 steel, or steel of an equivalent standard,
   ii. has a thickness equal to or greater than 3.04 mm (11 gauge), and
   iii. is weather resistant.
d. TC Class 117 tank cars, other than specification TC117R or TC117P, must be equipped with a tank head puncture resistance system that meets the requirements of clause 8.2.8.
e. For TC Specification 117R (retrofit) tank cars, the following additional requirements apply:
   i. The tank car must be equipped at both ends with a full head shield that is made with structural or pressure vessel steel plate that has a thickness equal to or greater than 12.7 mm (1/2 in.).
   ii. The tank car tank must have been manufactured prior to October 1, 2015, comply with the Class 111 specification that was in force at the time of its manufacture, have a tank test pressure of 689 kPa (100 psi) and have a tank burst pressure of 3447 kPa (500 psi).
f. For TC Specification 117P (performance standard) tank cars, the following additional requirements apply:
   i. In the case of a retrofitted tank car, the tank car tank must have been manufactured prior to October 1, 2015, comply with the Class 111 specification that was in force at the time of its manufacture, have a tank test pressure of 689 kPa (100 psi) and have a tank burst pressure of 3447 kPa (500 psi).
   ii. The tank car must pass a side impact test and a head impact test carried out in accordance with Appendices A and B. A tank car passes the impact test if, at rest, there is no leak visible from the tank shell or head within at least one hour of the side impact test and within at least one hour of the head impact test.
   iii. In addition to the approval requirements of clause 6.2, the design of the tank car must be approved by the Director.

8.3.25.3 Lined Tanks

8.3.25.3.1 Tanks Lined with Rubber

a. Commodities requiring a tank car tank to be lined with rubber must use a rubber or other rubber compound that is either vulcanized or bonded directly to the metal to provide a non-porous laminated lining compatible with the intended commodity. The thickness of the lining must be a minimum of 3.97 mm (5/32 in.);

b. Before a tank car tank is lined, a report certifying that the tank car and its equipment are in compliance with TC Specification 111A100W5 or 117A100W5 must be furnished by the tank car owner to the tank car facility who is to apply the lining. A copy of this report, certifying that the tank car tank has been lined in conformance with all requirements of TC Specification 111A100W5 or 117A100W5 must be furnished by the tank car facility lining the tank car tank to the lining owner. The lining owner must retain reports of the latest lining application until the next relining has been accomplished and recorded.

c. The seams joining the rubber must:
   i. overlap at a minimum of 38.1 mm (1.5 in.) at all edges and the edges must be straight and beveled to an angle of approximately 45° or, if the edges of the lining are butted, the butted edges must be sealed with a minimum 76.2 mm (3 in.) strip of lining having approximately 45° beveled edges; or
   ii. be joined with a skived butt seam and then capped with a separate strip of lining having a width of 76.2 mm (3 in.) and having approximately 45° beveled edges.

d. The lining must have an additional reinforcing pad applied on the bottom of the tank car tank directly under the manway opening. The reinforcing pad:
   i. Must be vulcanized to the lining on the bottom of the tank;
   ii. Must have a minimum area of 0.418 m^2 (4.5 ft^2);
   iii. Must make up a total minimum thickness with the lining of 12.7 mm (1/2 in);
   iv. Edges must be beveled at an angle of approximately 45°; and
   v. May have an opening for sump if so equipped.

e. The interior of the tank car tank must be free from scale, oxidation, moisture, and all foreign matter during the lining operation. No part of the lining or reinforcing pad must be under tension when applied.

f. Lining application must be inspected in accordance with 9.5.11.

8.3.25.3.2 Tanks Lined with Other Materials

a. Other lining materials may be used provided the material is compatible with the dangerous goods and is suitable for the service temperatures.

b. A tank car tank or each compartment of a tank car tank may be lined with elastomeric polyvinyl-chloride having a lining thickness equal to or greater than 2.38 mm (3/32 in.);

c. A tank car tank or each compartment of a tank car tank may be lined with elastomeric polyurethane having a lining thickness equal to or greater than 1.59 mm (1/16 in.);

d. Hard rubber or polyvinyl chloride may be used for the pressure-retaining parts of safety vents provided the material is compatible with the dangerous goods and is suitable for the service temperatures;

e. All surfaces of attachments or service equipment and their closures that are exposed to the dangerous goods must be covered with acid-resistant material having a thickness equal to or greater than 3.18 mm (1/8 in.). Attachments made of metal that are not affected by the dangerous goods need not be covered with rubber or other acid-resistant material.

8.3.25.4 Material

All service equipment, tubes, castings, and all projections and their closures, but not protective housings, must conform to the requirements specified in ASTM A262, except that when preparing the specimen for testing, the carburized surface may be finished by grinding or machining.

8.3.25.5 Manways and Manway Closures

8.3.25.5.1 The manway cover must be designed to make it impossible to remove the cover while the interior of the tank is under pressure.

8.3.25.5.2 In the case of a TC Specification 111A100W5 or 117A100W5 tank car tank:

a. the manway cover must be made of metal;

b. the bottom of the manway cover must be lined with an acid-resistant material applied in accordance with the requirements set out in clause 8.3.25.3 unless it is made of metal that is compatible with the dangerous goods; and

c. through-bolt holes must be lined with acid-resistant material having a thickness equal to or greater than 3.18 mm (1/8 in.).

8.3.25.5.3 The manway flange and cover must conform to the requirements set out in par. M3.3 of the AAR *Specifications for Tank Cars* publication.

8.4 General Requirements Applicable to TC Class 115 Tank Car Tanks Consisting of an Inner Container Supported Within an Outer Shell

8.4.1 General

TC Specification 115 tank car tanks must conform to the requirements set out in this clause, except where otherwise provided by the individual specification.

8.4.2 TC Specification 115 Tank Car Tanks

TC Specification 115 tank car tanks must consist of an inner container, a support system for the inner container, and an outer shell.

8.4.3 Inner Container and Outer Shell

8.4.3.1 The inner container must:

a. be a fusion-welded tank of circular cross section with formed convex outward heads; and

b. have a manway on top of the tank conforming to the requirements set out in this section.

8.4.3.2 If the inner container is divided into compartments, each compartment is considered to be a separate container.

8.4.3.3 The outer shell must be a fusion-welded tank with formed convex outward heads.

8.4.4 Insulation

The annular space between the inner container and the outer shell must contain insulation material. The insulation material must be of sufficient thickness so that the overall thermal conductance at 15.6 °C (60 °F) is equal to or less than 0.777 $\text{kJ/h}\cdot\text{m}^{2}\cdot{}^{\circ}\text{C}$ (0.038 $\text{Btu/h}\cdot\text{ft.}^{2}\cdot{}^{\circ}\text{F}$).

8.4.5 Minimum Thickness

8.4.5.1 The minimum thickness, in millimetres (inches), after forming of the inner container shell and of 2:1 ellipsoidal heads must be the greater of:

a. the minimum plate thickness specified in clause 8.4.23.1; and

b. the plate thickness calculated using the following formula:

$$t = \frac{Pd}{2SE}$$

where:

t = minimum thickness of plate, in mm (in.), after forming

P = minimum burst pressure, in MPa (psi)

d = inside diameter, in mm (in.)

S = minimum tensile strength of plate material, in MPa (psi), as specified in clause 8.4.6

E = 0.9, a factor representing the efficiency of welded joints, except that for welds that are 100% radiographed, $E = 1.0$

8.4.5.2 The minimum thickness, in millimetres (inches), after forming of the inner container heads, if the heads are flanged and dished, must be the greater of:

a. the minimum plate thickness specified in clause 8.4.23.1; and

b. the plate thickness calculated using the following formula:

$$t = \frac{5PL}{6SE}$$

where:

t = minimum thickness of plate, in mm (in.), after forming

P = minimum burst pressure, in MPa (psi)

L = main inside radius to which the head is dished, measured on the concave side, in mm (in.)

S = minimum tensile strength of plate material, in MPa (psi), as specified in clause 8.4.6

E = 0.9, a factor representing the efficiency of welded joints, except that for welds that are 100% radiographed, *E* = 1.0

8.4.5.3 The wall thickness, after forming, of the cylindrical section and heads of the outer shell must be equal to or greater than 11.1 mm (7/16 in.).

8.4.5.4 If the inner container is divided into compartments, the thickness must conform to the requirements specified in clauses 8.4.9 and 8.4.10.

8.4.6 Metal Plate for Inner Container and Nozzles

8.4.6.1 Carbon and Low Alloy Steel Plate:

a. must conform to one of the following specifications and grades: ASTM A516/A516M, Grade 70/485 or AAR TC128, Grade B;

b. must have a maximum carbon content of 0.31%; and

c. may be clad with other materials authorized in Appendix M of the AAR *Specifications for Tank Cars* publication.

8.4.6.2 Aluminum Alloy Plate:

a. must be used in one of the following tempers: 0, H112, or H32, except for alloy 5083 that must be used in the 0 temper only;

b. filler material alloy conforming to unified Numbering System UNS A95556 must not be used; and

c. the plate must conform to one of the specifications and corresponding minimum tensile strength set out in the following table:

Specification	Minimum Tensile Strength MPa (psi)
ASTM B209M or B209, Alloy 5052	172 (25 000)
ASTM B209M or B209, Alloy 5083	262 (38 000)
ASTM B209M or B209, Alloy 5086	241 (35 000)
ASTM B209M or B209, Alloy 5154	207 (30 000)
ASTM B209M or B209, Alloy 5254	207 (30 000)
ASTM B209M or B209, Alloy 5454	214 (31 000)
ASTM B209M or B209, Alloy 5652	172 (25 000)

8.4.6.3 High Alloy Steel Plate

In the case of high alloy steel plate, the plate must conform to one of the following specifications and types: ASTM A240/A240M Type 304, 304L, 316, or 316L.

8.4.6.4 Manganese-molybdenum Steel Plate

In the case of manganese-molybdenum steel plate, the manganese-molybdenum steel plate must conform to specification ASTM A302/A302M, Grade B.

8.4.7 Metal Plate for Outer Shell

8.4.7.1 The cylindrical section and heads of the outer shell must be manufactured from the materials listed in clause 8.4.6, and, in the case of steel plate materials, listed in clauses 8.4.6.1, 8.4.6.3, or 8.4.6.4;

a. The maximum carbon content is 0.31%; and

b. The steel plate may be clad with other materials authorized in Appendix M of the AAR *Specifications for Tank Cars* publication.

8.4.8 Material for Service Equipment

All service equipment on the inner container in contact with the dangerous goods must be made with materials that are compatible with the plate material of the inner container and be compatible with the dangerous goods or must be coated or lined with suitable corrosion-resistant material. Materials for castings and fittings must conform to the requirements set out in par. M4.5 of the AAR *Specifications for Tank Cars* publication.

8.4.9 Tank Heads

8.4.9.1 Heads of the inner container, the compartments of the inner container, and the outer shell must be flanged and dished or have the form of an ellipsoid and must be convex outward.

8.4.9.2 Ellipsoidal heads must be an ellipsoid of revolution in which the major axis is equal to the diameter of the shell and the minor axis is equal to one-half the major axis.

8.4.9.3 Flanged and dished heads must have:

a. a main inside radius equal to or less than 3048 mm (120 in.); and

b. an inside knuckle radius equal to or greater than:

  i. 95.3 mm (3.75 in.) for steel and alloy steel tanks; and

  ii. 127 mm (5 in.) for aluminum alloy tanks.

8.4.10 Compartmented Tanks

8.4.10.1 The inner container may be divided into compartments by:

a. inserting interior heads;

b. manufacturing each compartment as a separate container and joining the compartments with a cylinder; or

c. manufacturing each compartment as a separate tank without joining the compartments with a cylinder.

8.4.10.2 Each compartment must be capable of withstanding, without evidence of yielding or leakage, the required tank test pressure applied in each compartment separately or in any combination of compartments.

8.4.10.3 If the inner container is divided into compartments by manufacturing each compartment as a separate container and joining the compartments with a cylinder:

a. the cylinder must have a plate thickness equal to or greater than that required for the inner container shell;

b. the cylinder must be applied to the outside surface of the straight flange portion of the container head;

c. the cylinder must fit the straight flange tightly for a distance of at least two times the plate thickness or 25.4 mm (1 in.), whichever is greater;

d. the cylinder must be joined to the straight flange by a full fillet weld; and

e. the distance from fillet weld seam to container head seam must be equal to or greater than 38.1 mm (1.5 in.) or three times the plate thickness, whichever is greater.

8.4.11 Welding

8.4.11.1 Welders must comply with and welding procedures must conform to the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.4.11.2 Radiography of the outer shell is not a specification requirement.

8.4.12 Post-weld Heat Treatment

8.4.12.1 Post-weld heat treatment of the inner container is not required.

8.4.12.2 Post-weld heat treatment of the cylindrical portions of the outer shell to which the anchorage or draft sills are attached must conform to the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.4.12.3 If cold-formed heads are used on the outer shell and post-weld heat treatment is not practicable due to assembly procedures, the cold-formed heads must be heat-treated before welding to the cylindrical section of the outer shell.

8.4.13 Inner Container Manway Nozzle and Cover

8.4.13.1 A manway nozzle must be designed with an access opening having an inside diameter equal to or greater than 457 mm (18 in.) or at least 356 x 457 mm (14 x 18 in.) obround or oval.

8.4.13.2 The design of the manway nozzle and its cover must ensure a secure closure and must prevent the removal of the cover while the tank interior is under pressure.

8.4.13.3 All joints between manway covers and their seats must be made vapour-tight and liquid-tight by the use of suitable gaskets.

8.4.13.4 Manway covers must be of cast, forged, or fabricated metal and must conform to the requirements of clause 8.4.8.

8.4.13.5 A seal must be provided between the manway nozzle of the inner container and the opening in the outer shell.

8.4.14 Opening in the Tanks

Openings in the inner container and the outer shell must be reinforced in conformance with Appendix E of the AAR *Specifications for Tank Cars* publication. In calculating the required reinforcement area for openings in the outer shell, "t" must be equal to 6.35 mm (¼ in.).

8.4.15 Support System for Inner Container

8.4.15.1 The inner container must be supported within the outer shell by a support system of such strength and ductility that, at the operating temperature of the support system, the system is capable of supporting the inner container when filled with liquid dangerous goods to any level.

8.4.15.2 The support system must be designed to support, without yielding, impact loads producing accelerations of the following magnitudes and directions when:

a. the inner container is loaded so that the tank car is at its rail load limit; and

b. the tank car is equipped with a conventional AAR Specification M-901 draft gear:

i.	Longitudinal	7g
ii.	Transverse	3g
iii.	Vertical	3g

8.4.15.3 The longitudinal acceleration may be reduced to 3g if a cushioning device, which has been tested to demonstrate its ability to limit tank car tank forces to a maximum of 1779 kN (400 000 lbf) at an impact speed of 16.1 km/h (10 mph), is used between the coupler and the tank structure.

8.4.15.4 The inner container must be thermally isolated from the outer shell to the maximum practical extent.

8.4.15.5 The inner container and outer shell must be electrically bonded to each other, either by the support system used, by piping, or by a separate electrical connection.

8.4.16 Gauging Devices, Top Loading and Unloading Devices, Venting and Air Inlet Devices

8.4.16.1 Each device must be designed to prevent interchange with any other service equipment.

8.4.16.2 Each pipe must be securely anchored within the inner container.

8.4.16.3 Each inner container or compartment of an inner container may be equipped with one separate air connection.

8.4.16.4 If the dangerous goods are such that a device must be equipped with valves or fittings to permit the loading and unloading of the dangerous goods, each device, including valves or fittings, must be enclosed within a protective housing.

8.4.16.5 Protective housings are not required when plug or ball-type valves are used and their operating handles are removed.

8.4.16.6 Provision must be made for closing the pipe connections of valves.

8.4.16.7 An inner container may be equipped with a vacuum-relief valve and, if an inner container is so equipped, a protective housing is not required.

8.4.16.8 When a gauging device is required, an outage indicator visible through the manway opening must be provided.

8.4.16.9 If loading devices are applied to permit tank loading with the cover closed, a telltale pipe may be used. The telltale pipe must be capable of indicating that the required outage is provided. The pipe must be equipped with a control valve equal to or less than ¼ in. NPT mounted outside the tank and enclosed within a protective housing.

8.4.16.10 Other devices may be used instead of the outage indicator or a telltale pipe referred to in clauses 8.4.16.8 or 8.4.16.9.

8.4.16.11 A sump or siphon bowl, welded or pressed into the shell, must conform to the following requirements:

a. The sump or siphon bowl must be made of cast, forged, or fabricated metal that is weldable to the metal of the tank shell;

b. If the sump or siphon bowl is pressed into the bottom of the inner container shell, the wall thickness of the pressed section must be equal to or greater than that specified for the shell;

c. The section of a tank of circular cross section to which the sump or siphon bowl is attached need not conform to the out-of-roundness requirement set out in par. W13.5 of the AAR *Specifications for Tank Cars* publication; and

d. Any portion of the sump or siphon bowl not forming a part of a cylinder of revolution must have walls of such thickness and be so reinforced that the stresses in the walls caused by a given internal pressure are equal to or less than the circumferential stress that would exist under the same internal pressure in the wall of a tank of circular cross section designed in conformance with the requirements set out in clause 8.4.5.1 and, if applicable, clause 8.4.10. The wall thickness must be equal to or greater than that specified in clause 8.4.23.1.

e. Protective housing, if required, must have a cover and sidewalls having a thickness equal to or greater than 3.02 mm (0.119 in.).

8.4.17 Bottom Outlets and Outer Shell Openings

8.4.17.1 The bottom outlet must not extend from the outer shell more than that authorized in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.4.17.2 Each bottom outlet reducer and secondary closure and their attachments must be secured to the tank car by, at least, a 9.53 mm (3/8 in.) chain or its equivalent, except that outlet closure plugs may be secured by a 6.35 mm (1/4 in.) chain or its equivalent.

8.4.17.3 If the bottom outlet closure is of the combination cap-and-valve type, the pipe connection to the valve must be closed by a plug, cap, or quick-coupling device.

8.4.17.4 The bottom outlet equipment must include only the valve, reducer, and closures that are necessary for the attachment to unloading equipment.

8.4.17.5 Each bottom outlet must be provided with a liquid-tight closure at its lower end.

8.4.17.6 The valve and its operating mechanism must be applied to the outside bottom of the inner container and the valve operating mechanism must include a means of locking the valve in the closed position during transport.

8.4.17.7 To provide for the attachment of unloading connections, the bottom of the main portion of the outlet nozzle or valve body, or any fixed attachment thereto, must be provided with a threaded cap closure arrangement or bolted flange closure arrangement having a maximum 1 in. NPT solid plug.

8.4.17.8 If the outlet nozzle and its closure extend below the bottom of the outer shell, the outlet nozzle must conform to the following requirements:

a. A breakage "V" groove or its equivalent must be cut, not cast, into the upper part of the outlet nozzle at a point immediately below the lowest part of the valve to a depth that leaves the thickness of the nozzle wall at the root of the "V" equal to or less than 6.35 mm (1/4 in.);

b. If the outlet nozzle on interior valves or the valve body on exterior valves is steam-jacketed, the breakage groove or its equivalent must be below the steam chamber but above the bottom of the centre sill for tank cars with continuous center sills;

c. If the outlet nozzle is not a single piece or if exterior valves are applied, provision must be made for the equivalent of the breakage groove;

d. On tank cars without continuous centre sills, the breakage groove or its equivalent must be equal to or less than 381 mm (15 in.) below the outer shell; and

e. On tank cars with continuous centre sills, the breakage groove or its equivalent must be above the bottom of the centre sill.

8.4.17.9 The thickness of the valve body must be such that it is capable of:

a. preventing distortion of the valve or valve seat by any change in contour of the inner container shell resulting from the expansion of the dangerous goods or from other causes; and

b. ensuring that accidental breakage of the outlet nozzle will occur at or below the breakage "V" groove or its equivalent.

8.4.17.10 The valve must have no wings or stem projecting below the breakage "V" groove or its equivalent. The valve and valve seat must be readily accessible or removable for repairs, including grinding;

8.4.18 Bottom Washouts

8.4.18.1 The bottom washout equipment must not extend from the outer shell more than that authorized in Appendix E of the AAR *Specifications for Tank Cars* publication.

8.4.18.2 If the washout nozzle extends below the bottom of the outer shell, the washout nozzle must conform to the following requirements:

a. A breakage "V" groove must be cut, not cast, in the upper part of the washout nozzle at a point immediately below the lowest part of the inside closure seat or plug to a depth that leaves the thickness of the nozzle wall at the root of the "V" equal to or less than 6.35 mm (1/4 in.);

b. If the washout nozzle is not a single piece, provision must be made for the equivalent of the breakage groove;

c. The thickness of the washout nozzle must be sufficient to ensure that accidental breakage will occur at or below the breakage "V" groove or its equivalent;

d. On tank cars without continuous centre sills, the breakage "V" groove or its equivalent must be equal to or less than 381 mm (15 in.) below the outer shell; and

e. On tank cars with continuous centre sills, the breakage "V" groove or its equivalent must be above the bottom of the centre sill.

8.4.18.3 The closure plug and seat must be readily accessible or removable for repairs, including grinding.

8.4.18.4 The closure of the washout nozzle must be equipped with a 3/4 in. NPT solid plug. The plug must be attached to its nozzle by, at least, a 6.35 mm (1/4 in.) chain.

8.4.18.5 Joints between closures and their seats must be gasketed with suitable material.

8.4.19 Plugs for Openings

8.4.19.1 Each plug must be solid, with NPT threads, and must be of a length that will screw at least six threads inside the face of the fitting or tank.

8.4.19.2 Each plug, if inserted from the outside of the outer shell tank heads, must have the letter "S" equal to or greater than 9.53 mm (3/8 in.) in height stamped with a steel stamp or cast on the outside surface. The letter "S" indicates that the plug is solid.

8.4.20 Pressure Testing of the Inner Container

8.4.20.1 Each inner container or compartment must be tested hydrostatically to a pressure equal to or greater than the specification test pressure.

8.4.20.2 The temperature of the pressurizing medium must be equal to or less than 37.8 °C (100 °F) during the test.

8.4.20.3 The inner container must hold the specified pressure for at least 10 min without evidence of yielding or leakage.

8.4.20.4 Pressure-relief devices must be removed during the test.

8.4.20.5 The inner container must be pressure-tested before installation within the outer shell.

8.4.20.6 Items that, because of assembly sequence, must be welded to the inner container after its installation within the outer shell must have their attachment welds thoroughly inspected by a non-destructive evaluation method conforming to Appendix T of the AAR *Specifications for Tank Cars* publication

8.4.21 Permanent Markings

Subject to clause 7.3, the marking on a Specification 115 tank car tank must conform to the following requirements:

8.4.21.1 Each outer shell must have permanent markings, including:

a. tank car tank specification;

b. month and year of the original pressure test of the inner container;

c. inner container manufacturer's identifying mark;

d. material specification of the inner container;

e. as-built thickness of the shell and heads of the inner container;

f. material specification of the outer shell;

g. outer shell manufacturer's identifying mark; and

h. tank assembler's identifying mark, if different from the inner container or outer shell manufacturer; and

8.4.21.2 The permanent markings must be stamped in letters and figures equal to or greater than 9.53 mm (3/8 in.) in height into the metal near the centre of both outside heads. The inner container heads must not be stamped. The following is an example of the required markings.

TC 115A60W6

12-2001

ABC

Inner/Intér. ASTM A240 316L

Head/Tête 0.150 in./po

Shell/Coque 0.167 in./po
Outer/Extér. ASTM A516 -70
Outer/Extér. DEF
Assembler/Assembleur KLM

8.4.22 Stencilling

8.4.22.1 The outer shell must be stencilled in conformance with clause 7.2.1.

8.4.22.2 The safe upper temperature limit, if applicable, for the inner tank, insulation and support system must be applied by stencilling on both sides of the outer shell near the centre in letters and figures equal to or greater than 38.1 mm (1.5 in.) in height.

8.4.23 Individual Specification Requirements Applicable to TC Specification 115 Tank Car Tanks

8.4.23.1 Individual Specification Minimum Requirements

In addition to the applicable requirements set out in clause 8.4.1, the inner container must conform to the individual specification requirements corresponding to the TC Specification set out in the following table:

Individual Specification Minimum Requirements

TC Specification	Minimum Inner Container Thickness mm (in.)	Tank Burst Pressure kPa (psi)	Test Pressure kPa (psi)	Bottom Outlet	Bottom Washout
115A60ALW	4.76 (3/16)	1654 (240)	414 (60)	Optional	Optional
115A60W1	3.18 (1/8)	1654 (240)	414 (60)	Optional	Optional
115A60W6	3.18 (1/8)	1654 (240)	414 (60)	Optional	Optional

8.5 General Requirement Applicable to TC Class 106A and TC Class 110A Ton Containers

8.5.1 General

A TC Specification 106A and TC Specification 110A ton container must conform to the requirements set out in this section and any other applicable requirements set out in this standard.

8.5.2 TC Specification 106A and 110A ton containers

Each ton container must be cylindrical and circular in cross section. All openings must be located in the head. Each ton container must have a water capacity of at least 680 kg (1500 lb) and not more than 1179 kg (2600 lb).

8.5.3 Insulation

Insulation is prohibited.

8.5.4 Burst Pressure

The minimum burst pressure must conform to the requirements specified in clause 8.5.19.

8.5.5 Minimum Shell Thickness

The shell thickness must conform to the following requirements:

8.5.5.1 For a Specification 110A ton container, the shell thickness of the cylindrical portion, must be the greater of:

a. the minimum thickness of shell specified in clause 8.5.19; and

b. the shell thickness calculated using the following formula:

$$t = \frac{Pd}{2SE}$$

where:

t = minimum thickness of shell, in mm (in.), after forming

P = minimum burst pressure, in MPa (psi), where 1 MPa = 1000 kPa

d = inside diameter, in mm (in.)

S = minimum tensile strength of plate material, in MPa (psi), as specified in clause 8.5.6

E = 1.0, a factor representing the efficiency of welded joints

8.5.5.2 For a Specification 106A ton container, the shell thickness of the cylindrical portion must be equal to or greater than that specified in clause 8.5.19 and must be such that, at the tank test pressure, the maximum fibre stress in the tank shell is equal to or less than 108.6 MPa (15 750 psi) as calculated using the following formula:

$$s = \frac{P\left(1.3D^2 + 0.4d^2\right)}{D^2 - d^2}$$

where:

s = shell stress, in MPa (psi)

P = tank test pressure, in MPa (psi)

D = outside diameter, in mm (in.)

d = inside diameter, in mm (in.)

8.5.5.3 If cladding material having a lower tensile strength is used, the thickness of the cladding shall not be included in the calculation of minimum shell thickness.

8.5.6 Metal Plate

8.5.6.1 The maximum carbon content for carbon and low alloy steel plate is 0.31%.

8.5.6.2 All plates must have their heat number and the name or brand of the manufacturer legibly stamped on them at the rolling mill.

8.5.6.3 The steel plates must conform to one of the specifications and corresponding minimum tensile strength set out in the following table:

Specification	Minimum Tensile Strength MPa (psi)
ASTM A240/A240M, Type 304	517 (75 000)
ASTM A240/A240M, Type 304L	483 (70 000)
ASTM A240/A240M, Type 316	517 (75 000)
ASTM A240/A240M, Type 316L	483 (70 000)
ASTM A240/A240M, Type 321	517 (75 000)
ASTM A285/A285M, Grade A	310 (45 000)
ASTM A285/A285M, Grade B	345 (50 000)
ASTM A285/A285M, Grade C	379 (55 000)
ASTM A515/A515M, Grade 65/450	448 (65 000)
ASTM A515/A515M, Grade 70/485	483 (70 000)
ASTM A516/A516M, Grade 70/485	483 (70 000)

8.5.7 Tank Heads

8.5.7.1 For a Specification 110A ton container:

a. the tank must have fusion-welded heads, formed concave to pressure;

b. the heads must be 2:1 ellipsoidal with the major axis equal to the diameter of the shell and the minor axis equal to one-half the major axis;

c. the heads must be one piece and hot-formed so as to provide a straight flange having a length equal to or greater than 38.1 mm (1.5 in.); and

d. the head thickness must be equal to or greater than that calculated by the following formula:

$$t = \frac{Pd}{2SE}$$

where symbols are as defined in clause 8.5.5.1.

8.5.7.2 For a Specification 106A ton container,

a. the tank must have forge-welded heads, formed convex to pressure;

b. heads must be of torispherical form with an inside radius equal to or less than the inside diameter of the shell;

c. heads must be one piece and hot-formed so as to provide a straight flange having a length equal to or greater than 102 mm (4 in.);

d. heads must be drive fit into the shell for forge welding; and

e. the wall thickness of the heads, after forming, must conform to the test requirements set out in clause 8.5.5.2 and provide for adequate threading of openings.

8.5.8 Welding

8.5.8.1 Welders must comply with and welding procedures must conform to the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.5.8.2 Longitudinal joints in the shell must be fusion-welded.

8.5.8.3 Fusion-welded joints must conform to the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication, except that circumferential welds in tanks having an inside diameter less than 914 mm (36 in.) need not be radiographed.

8.5.8.4 Forge-welded joints must be hot-hammered or hot-rolled to ensure sound welds and:

a. the flanges of the heads must be forge lap-welded to the shell and then crimped inwardly toward the centreline at least 25.4 mm (1 in.) on the radius; and

b. welding and crimping must be accomplished in one heat cycle.

8.5.9 Post-weld Heat Treatment

After welding is complete a carbon steel ton container and all its welded attachments must be post-weld heat-treated as a unit in conformance with the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.5.10 Protection of Service Equipment

8.5.10.1 Ton containers must be designed to provide protection to any service equipment or attachment to the head, including the detachable protective housing referred to in clause 8.5.10.2. Tank ends must slope or curve inward toward the axis so that the diameter at each end is at least 50.8 mm (2 in.) less than the maximum diameter.

8.5.10.2 Loading and unloading valves must be protected by a detachable housing which must not project beyond the end of the tank and must be securely fastened to the tank head. The detachable protective housing must not cover any pressure-relief devices of the ton container.

8.5.11 Venting, Loading, and Unloading Valves

8.5.11.1 Valves must be made of metal that is compatible with the dangerous goods and must withstand tank test pressure without leakage.

8.5.11.2 Valves must be screwed directly into or attached to one of the tank heads.

8.5.11.3 The outlet connections of the valves must be closed.

8.5.11.4 Threads for openings must be NGT tapped to gauge, clean cut, even, and without checks.

8.5.12 Attachments Not Otherwise Specified

Siphon pipes and their couplings on the inside of the tank heads and lugs on the outside of the tank heads for attaching the valve protective housing must be fusion-welded in place prior to post-weld heat treatment.

8.5.13 Pressure-relief Devices

8.5.13.1 Unless otherwise prohibited in this standard, a tank must be equipped with one or more pressure-relief devices made of metal that is compatible with the dangerous goods and that are screwed directly into the tank heads.

8.5.13.2 The total discharge capacity of a pressure-relief device must be sufficient to prevent a build-up of pressure in the tank equal to or greater than 82.5% of the tank test pressure. If pressure-relief devices of the fusible plug type are used, the required discharge capacity must be available in each head.

8.5.13.3 For the purpose of calculating discharge capacity, the applicable formula specified in Appendix A of the AAR *Specifications for Tank Cars* publication must be used.

8.5.13.4 Threads for openings must be NGT tapped to gauge, clean cut, even, and without checks.

8.5.13.5 Pressure-relief devices, other than fusible plugs, must be set for start-to-discharge and rupture discs must burst at a pressure equal to or less than that specified in clause 8.5.19.1.

8.5.13.6 Fusible plugs must function at a temperature equal to or less than 79.4 °C (175 °F) and must be vapour-tight at a temperature equal to or greater than 54.4 °C (130 °F).

8.5.14 Pressure and Leak Testing

8.5.14.1 After post-weld heat treatment, each ton container must be subjected to a hydrostatic expansion test in a water jacket or be tested using a direct expansion method. The test method must conform to the requirements of the CGA Publication C-1 and conformance with par. 6.5 relative to the use of a calibrated cylinder may be substituted with an alternative method for test system accuracy verification.

8.5.14.2 No ton container must have been subjected previously to an internal pressure that is within 689 kPa (100 psi) of the test pressure.

8.5.14.3 (RESERVED)

8.5.14.4 (RESERVED)

8.5.14.5 No leaks must appear and permanent volumetric expansion must not exceed 10% of total volumetric expansion at test pressure.

8.5.14.6 After all service equipment has been installed, each ton container must be subjected to an air-pressure test at a pressure equal to or greater than 689 kPa (100 psi). A ton container successfully passes an air-pressure test when there is no evidence of yielding or leakage.

8.5.14.7 Any leaks must be repaired using the same processes that are employed in the manufacture of the ton container.

8.5.15 Testing of Pressure-relief Devices

8.5.15.1 Each reclosing pressure-relief device must be tested with air or gas and must open and be vapour-tight at the pressures specified in clause 8.5.19.1.

8.5.15.2 Rupture discs of non-reclosing pressure relief devices must be tested in conformance with the requirements set out in par. A4.3 of the AAR *Specifications for Tank Cars* publication.

8.5.15.3 For pressure-relief devices of the fusible plug type, a representative sample of the plug used must have functioned at the temperatures specified in clause 8.5.13.6.

8.5.15.4 The start-to-discharge and vapour-tight pressures must not be affected by an auxiliary closure.

8.5.16 Permanent Markings

8.5.16.1 The following information must be plainly and permanently stamped in letters and figures equal to or greater than 9.53 mm (3/8 in.) in height into the metal of the valve end chime of each tank:

a. Specification;

b. Ton container material and the cladding material designation, if any, stamped immediately below the specification number;

c. The owner's or manufacturer's identifying symbol and serial number, stamped immediately below the material identification;

d. The mark of the independent inspector referred to in clause 8.5.17, stamped immediately below the owner's or manufacturer's identifying symbol;

e. Date of original tank test (month and year, such as 1-10 for January 2010), which must be stamped so as to allow the easy addition of subsequent test date; and

f. The water capacity — In kilograms but may include pounds. [ex: 00 kg (00 lb)]

8.5.16.2 A copy of the above stamping in letters and figures of the specified height may be stamped on a brass plate and secured to one of the tank heads.

8.5.16.3 The owner or manufacturer's identifying symbol must be registered with Transport Canada.

8.5.17 Inspection

8.5.17.1 Each ton container must be inspected during manufacturing by an independent inspector registered under clause 6.5.

8.5.17.2 The independent inspector must verify that all plates from which the ton container are to be made conform to the specification and must obtain and review the records certifying that the plates conform to the specification.

8.5.17.3 The independent inspector must reject plates that do not conform to the requirements set out in clause 8.5.6.

8.5.17.4 The independent inspector must perform the inspections that are required to ensure that each ton container conforms to the requirements set out in this section, including the requirements for the marking, post-weld heat treatment and testing.

8.5.17.5 The independent inspector must stamp his official mark in conformance with clause 8.5.16 on each ton container that is accepted by the inspector as being in conformance with the requirements set out in this section and must provide the report required under clause 8.5.18.

8.5.18 Report

Before a tank is placed into service, the independent inspector must provide the manufacturer, ton container owner, and Director with a report certifying that the ton container and its equipment conform to the requirements of this standard.

8.5.19 Individual Specification Requirements Applicable to TC Ton Containers

8.5.19.1 Individual Specification Requirements

In addition to the other requirements set out in clause 8.5.1, a TC ton container must conform to the individual specification requirements corresponding to the specification set out in the following table:

TC Specification	106A500X	106A800X	110A500W	110A600W	110A800W	110A1000W
Minimum Burst Pressure, kPa (psi) (clause 8.5.4)	None specified	None specified	8618 (1250)	10342 (1500)	13789 (2000)	17236 (2500)

TC Specification	106A500X	106A800X	110A500W	110A600W	110A800W	110A1000W
Minimum Shell Thickness, mm (in.)	10.3 (13/32)	17.5 (11/16)	8.73 (11/32)	9.53 (3/8)	11.9 (15/32)	15.1 (19/32)
Tank Test Pressure, kPa (psi) (clause 8.5.14)	3447 (500)	5516 (800)	3447 (500)	4137 (600)	5516 (800)	6895 (1000)
Pressure-relief Device Maximum Start-to-discharge or Burst Pressure, kPa (psi)	2586 (375)	4137 (600)	2586 (375)	3103 (450)	4137 (600)	4826 (700)
Pressure-relief Device Minimum Vapour-tight Pressure, kPa (psi)	2068 (300)	3309 (480)	2068 (300)	2482 (360)	3309 (480)	4482 (650)

8.6 General Requirements Applicable to Class TC 113 Vacuum-insulated Tank Car Tanks for Cryogenic Liquids

8.6.1 General

A TC Specification 113 vacuum-insulated tank car must conform to the requirements set out in this clause and any other applicable requirements of this standard.

8.6.2 Type

A Specification 113 tank car tank must conform to the following requirements:

a. consists of an inner tank of circular cross section supported essentially concentric within an outer jacket of circular cross section, with the out-of-roundness of both the inner tank and outer jacket limited in accordance with the requirements set out in Section VIII, Division I, par. UG-80 of the ASME Code;
b. have the annular space evacuated, after filling the annular space with an insulating material;
c. have the inner tank heads concave to pressure;
d. have the outer jacket heads convex outward; and

e. be equipped with piping systems for the venting of vapour and the transfer of the dangerous goods and with pressure-relief devices and other service equipment as specified in this section.

8.6.3 Insulation System and Performance Standard

A Specification 113 tank car tank must conform to the following requirements:

8.6.3.1 Nomenclature

a. Standard Heat Transfer Rate (SHTR), expressed in kJ/day/kg (Btu/day/lb.) of water capacity, means the rate of heat transfer used for determining the satisfactory performance of the insulation system, as set out in the table of clause 8.6.24.1;

b. test refrigerated liquid means the refrigerated liquid, which may be different from the dangerous goods intended to be shipped in the tank car tank, being used during the performance tests of the insulation system;

c. Normal Evaporation Rate (NER), expressed in kg (lb) of the refrigerated liquid per day, means the rate of evaporation, determined by test, known as the NER test, of a test refrigerated liquid in a tank maintained at a pressure of approximately one bar (atmosphere), absolute;

d. stabilization period means the lapsed time after a tank car tank is filled with the test refrigerated liquid until the NER has stabilized or 24 h has passed, whichever is the greater; and

e. the Calculated Heat Transfer Rate (CHTR) is calculated using the following formula which uses test data obtained during the NER test:

$$q = \frac{N \cdot \Delta h \cdot (T - t_1)}{V \cdot \rho \cdot (t_s - t_f)}$$

where:

q = CHTR, in kJ/day/kg (Btu/day/lb) of water capacity

N = NER, determined by NER test, in kg/day (lb/day)

Δh = latent heat of vaporization of the test refrigerated liquid at the NER test pressure of approximately one bar (atmosphere), absolute, in kJ/kg (Btu/lb)

T = ambient temperature of 32.2 °C (90 °F)

t_1 = equilibrium temperature of the intended dangerous goods at maximum shipping pressure, in degrees Celsius (Fahrenheit)

V = water volume, at 15.6 °C (60 °F), of the inner tank, in L (US gallons)

ρ = specific gravity of water at 15.6 °C (60 °F), 0.999007 kg/L (8.33712 lb/US gallon)

t_s = average temperature of the outer jacket, determined by averaging jacket temperatures at various locations on the jacket at regular intervals during the NER test, in degrees Celsius (Fahrenheit)

t_f = equilibrium temperature of the test refrigerated liquid at the NER test pressure of approximately 100 kPa (1 atmosphere), absolute, in degrees Celsius(Fahrenheit)

8.6.3.2 A Specification 113A60W tank car must:

a. be filled with hydrogen, refrigerated liquid to the maximum permitted filling density specified in special provision 69 f., Schedule 1, Appendix E, before the NER test is conducted; and

b. have a CHTR equal to or less than the SHTR specified in the table of clause 8.6.24.1 for a Specification 113A60W tank car.

8.6.3.3 A Specification 113A90W tank car must:

a. be filled with argon, refrigerated liquid, nitrogen, refrigerated liquid, or oxygen, refrigerated liquid to the maximum permitted filling density specified in special provision 70 f., Schedule 1, Appendix E, before the NER test is conducted; and

b. have a CHTR equal to or less than the SHTR specified in the table of clause 8.6.24.1 for a Specification 113A90W tank car.

8.6.3.4 A Specification 113C120W or 113C140W tank car must:

a. be filled with:

   i. ethylene, refrigerated liquid, methane, refrigerated liquid, or natural gas, refrigerated liquid, with high methane content to the maximum permitted filling density specified in special provision 69 f., Schedule 1, Appendix E, before the NER test is conducted; or

   ii. nitrogen, refrigerated liquid to 90% of the volumetric capacity of the inner tank before the NER test is conducted; and

b. have a CHTR equal to or less than 75% of the SHTR specified in the table of clause 8.6.24.1 for a TC Specification 113C120W tank car.

8.6.3.5 If the insulation consists of a powder susceptible to settlement, the entire top of the cylindrical portion of the inner tank must be insulated with a layer of glass fibre insulation equal to or greater than 25.4 mm (1 in.) nominal thickness or equivalent, held in position and covering an area extending 25° to each side of the top centreline of the inner tank.

8.6.3.6 The outer jacket must be equipped with service equipment to permit evacuation of the annular space between the outer jacket and the inner tank.

8.6.3.7 The outer jacket must be equipped with a system to measure the absolute pressure in the annular space. The system must be permanently positioned so as to be easily visible or provide an easily accessible connection for the use of a portable device.

8.6.4 Metal Plate

8.6.4.1 Stainless steel of ASTM Specification A240/A240M, Type 304, or 304L must be used for the inner tank and its service equipment, as set out in Appendix M of the AAR *Specifications for Tank Cars* publication and must be in the annealed condition prior to fabrication, forming and fusion welding.

8.6.4.2 The outer jacket shell and heads must be made from steel specified in clause 8.3.5. Any steel casting, steel forging, steel structural shape, attached to the outer jacket or heads must be as set out in Appendix M of the AAR *Specifications for Tank Cars* publication.

8.6.4.3 Impact tests must be:

a. conducted in accordance with the requirements set out in par. W8.1 of the AAR *Specifications for Tank Cars* publication;

b. performed on specimens of the material taken in the longitudinal direction of rolling;

c. performed when the design service temperature is less than -195.5 °C (-320 °F);

d. performed at a temperature equal to or less than the tank design service temperature; and

e. performed on test plate welds and materials that are used to manufacture the inner tank and service equipment and that are subject to the refrigerated liquid temperatures.

8.6.4.4 Impact test results must be equal to or greater than those set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.6.4.5 The report of impact tests must include the absorbed energy results and the lateral expansion data for each tested specimen.

8.6.5 Burst and Buckling Pressure

8.6.5.1 The inner tank must have a burst pressure equal to or greater than that specified in clause 8.6.24.1.

8.6.5.2 The outer jacket must be designed in accordance with the requirements set out in clauses 8.6.7.4 and 8.6.7.5, and must conform to the design loads and stresses specified in par. 6.2 of the AAR *Design, Fabrication and Construction of Freight Cars* publication. The designs and calculations must take into account the loads transferred to the outer jacket through the support system.

8.6.6 Heads

8.6.6.1 A tank head of the inner tank and outer jacket must be flanged and dished, or have the form of an ellipsoid of revolution.

8.6.6.2 A flanged and dished head must have:

a. a main inside dish radius equal to or less than the outside diameter of the straight flange;

b. an inside knuckle radius equal to or greater than 6% of the outside diameter of the straight flange; and

c. an inside knuckle radius equal to or greater than three times the head thickness.

8.6.7 Minimum Thickness

8.6.7.1 The minimum wall thickness, after forming, of the inner tank shell and any 2:1 ellipsoidal inner tank head must be the greater of:

a. the applicable minimum plate thickness of the shell and the applicable minimum head thickness specified in clause 8.6.24.1; and

b. the thickness calculated using the following formula:

$$t = \frac{Pd}{2SE}$$

where:

t = minimum thickness of plate material, in mm (in.), after forming

P = minimum burst pressure, in MPa (psi)

d = inside diameter, in mm (in.)

S = minimum tensile strength of the plate material, as set out in Table M.10.3, of the AAR *Specifications for Tank Cars* publication, in MPa (psi)

E = 0.9, a factor representing the efficiency of welded joints, except that for seamless heads, $E = 1.0$

8.6.7.2 The minimum wall thickness, measured after forming, of any 3:1 ellipsoidal inner tank head must be the greater of:

a. the minimum head thickness specified in clause 8.6.24.1; and

b. the thickness calculated using the following formula:

$$t = \frac{1.83Pd}{2SE}$$

where:

t = minimum thickness of plate material, in mm (in.), after forming

P = minimum burst pressure, in MPa (psi)

d = inside diameter, in mm (in.)

S = minimum tensile strength of the plate material, as set out in Table M.10.3, of the AAR *Specifications for Tank Cars* publication, in MPa (psi)

E = 0.9, a factor representing the efficiency of welded joints, except that for seamless heads, $E = 1.0$

8.6.7.3 The minimum wall thickness, after forming, of a flanged and dished head for the inner tank must be the greater of:

a. the minimum head thickness specified in clause 8.6.24.1; and

b. the thickness calculated using the following formula:

$$t = \frac{PL\left[3 + (L/r)^{0.5}\right]}{8SE}$$

where:

t = minimum thickness of plate, in mm (in.), after forming

P = minimum burst pressure, in MPa (psi)

L = main inside radius of dished head, in mm (in.)

r = inside knuckle radius, in mm (in.)

S = minimum tensile strength of plate material, as set out in Table M.10.3, of the AAR *Specifications for Tank Cars* publication, in MPa (psi)

E = 0.9, a factor representing the efficiency of welded joints, except that for seamless heads, $E = 1.0$

8.6.7.4 The minimum wall thickness, after forming, of the outer jacket shell must be equal to or greater than 11.1 mm (7/16 in.).

8.6.7.5 The minimum wall thickness, after forming, of the outer jacket heads must be equal to or greater than 12.7 mm (1/2 in.).

8.6.7.6 The annular space must be evacuated and the cylindrical portion of the outer jacket between the heads, or between the stiffening rings if stiffening rings are used, must be designed to withstand an external critical collapsing pressure equal to or greater than 0.259 MPa (37.5 psi), as calculated using the following formula:

$$P_c = \frac{2.6E(t/D)^{2.5}}{(L/D) - 0.45(t/D)^{0.5}}$$

where:

P_c = critical collapsing pressure equal to or greater than 0.259 MPa (37.5 psi)

E = modulus of elasticity of outer jacket material, in MPa (psi)

t = minimum thickness of outer jacket material, in mm (in.), after forming

D = outside diameter of outer jacket, in mm (in.)

L = distance between stiffening ring centres, in mm (in.)

(The outer jacket heads may be considered as stiffening rings located one-third of the head depth from the head tangent line.).

8.6.8 Stiffening Rings

8.6.8.1 If stiffening rings are used in designing the outer jacket shell for external pressure:

a. the stiffening rings must be attached to the outer jacket by means of fillet welds;

b. outside stiffening ring attachment welds must be continuous on each side of the ring;

c. inside stiffening ring attachment welds may be intermittent welds on each side of the ring and the total length of weld on each side must be equal to or greater than one-third of the circumference of the tank; and

d. the maximum space between welds must not exceed eight times the outer jacket wall thickness.

8.6.8.2 A portion of the outer jacket may be included when calculating the moment of inertia of the ring.

8.6.8.3 The effective width of jacket plate on each side of the attachment of the stiffening ring must be the width calculated using the following formula:

$$W = 0.78 \times \sqrt{Rt}$$

where:

W = width of jacket effective on each side of the stiffening ring, in mm (in.)

R = outside radius of the outer jacket, in mm (in.)

t = plate thickness of the outer jacket, in mm (in.), after forming.

8.6.8.4 If a stiffening ring is used that consists of a closed section having two webs attached to the outer jacket:

a. the jacket plate between the webs may be included up to the limit of twice the value of "*W*," as defined in clause 8.6.8.3;

b. the outer flange of the closed section, if not a steel structural shape, is subject to the same limitations of "*W*" as in clause 8.6.8.4 a., based on the "*R*" and "*t*" values of the flange as defined in clause 8.6.8.3;

c. if two separate members, such as two angles, are located less than twice the value of "*W*" apart, as defined in clause 8.6.8.3, they may be treated as a single stiffening ring member;

d. the maximum length of plate, which may be considered effective, is four times the value of "*W*", as defined in clause 8.6.8.3; and

e. the closed section between an external ring and the outer jacket must be provided with an opening for drainage.

8.6.8.5 The stiffening ring must have a moment of inertia large enough to support the critical collapsing pressure, as calculated using one of the following formulas:

$$I = \frac{0.035\,D^3 L P_c}{E}$$

or

$$I' = \frac{0.046\,D^3 L P_c}{E}$$

where:

I = required moment of inertia of stiffening ring about the centroidal axis parallel to the outer jacket axis, in mm (in.) to the fourth power

I' = required moment of inertia of combined section of stiffening ring and effective width of jacket plate about the centroidal axis parallel to the outer jacket axis, in mm (in.) to the fourth power

D = outside diameter of the outer jacket, in mm (in.)

L = one-half of the distance from the centre line of the stiffening ring to the next line of support on one side plus one-half of the distance from the centreline to the next line of support on the other side of the stiffening ring. Both distances are to be measured parallel to the axis of the vessel, in mm (in.). A line of support is:

(1) a stiffening ring that conforms to the requirements of this paragraph; or

(2) a circumferential line of a head at one-third the depth of the head from the tangent line.

P_c = critical collapsing pressure equal to or greater than 0.259 MPa (37.5 psi)

E = modulus of elasticity of stiffening ring material, in MPa (psi).

8.6.8.6 If loads are applied to the outer jacket or to stiffening rings from the supports of the inner tank, additional stiffening rings or an increased moment of inertia of the stiffening rings designed for the external pressure must be provided to carry the support loads.

8.6.9 Sump or Siphon Bowl

A sump or siphon bowl must not be installed unless it is located in the bottom of the inner tank shell and conforms to the following requirements:

a. it is formed directly into the inner tank shell or if it is formed and welded to the inner tank shell, it must be made of metal that is weldable to the metal of the inner tank shell;

b. the stress in any orientation under any condition is equal to or less than the circumferential stress in the inner tank shell; and

c. the wall thickness is equal to or greater than that specified in clause 8.6.24.1.

8.6.10 Welding

8.6.10.1 Except for closure of openings and a maximum of two circumferential closing joints in the outer jacket shell, each joint of an inner tank and the outer jacket must be a fusion, double-welded butt joint.

8.6.10.2 The closure for openings and the circumferential closing joints in the outer jacket shell, including head-to-shell joints, may be a single-welded butt joint using a backing strip on the inside of the joint.

8.6.10.3 Each joint must be welded in accordance with the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.6.11 Post-weld Heat Treatment

8.6.11.1 Post-weld heat treatment of the inner tank is not required.

8.6.11.2 The outer jacket shell, with the exception of the circumferential closing seams, must be post-weld heat-treated as set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.6.11.3 Any item to be welded to the outer jacket shell must be welded before post-weld heat treatment.

8.6.11.4 Welds securing the following need not be post-weld heat-treated if such post-weld heat treatment is not practical due to final assembly procedures:

a. the inner tank support system to the outer jacket;

b. connections at piping penetrations;

c. closures for access openings; and

d. circumferential closing joints of head-to-shell joints.

8.6.11.5 If cold-formed heads are used on the outer jacket and post-weld heat treatment is not practical due to assembly procedures, the cold-formed heads must be heat-treated before they are welded to the outer jacket shell.

8.6.12 Support System for Inner Tank

8.6.12.1 The inner tank must be supported within the outer jacket by a support system.

8.6.12.2 The strength and ductility, at operating temperatures, of the support system and its areas of attachment to the outer jacket must be capable of supporting the inner tank when filled with the dangerous goods to any level during normal conditions of transport.

8.6.12.3 The support system must be designed to support, without yielding, impact loads producing accelerations of the following magnitudes and directions when the inner tank is fully loaded and the tank car is equipped with a conventional AAR M-901 draft gear:

a. Longitudinal	7g
b. Transverse	3g
c. Vertical	3g

8.6.12.4 The longitudinal acceleration may be reduced to 3g if a cushioning device, which has been tested to demonstrate its ability to limit tank car tank forces to a maximum of 1779 kN (400 000 lbf) at an impact speed of 16.1 km/h (10 mph), is used between the coupler and the tank structure.

8.6.12.5 The inner tank and outer jacket must be electrically bonded to each other by the support system used, by piping, or by a separate electrical connection.

8.6.13 Radiography

Each longitudinal and circumferential joint of the inner tank and each longitudinal and circumferential double-welded butt joint of the outer jacket must be examined along its entire length in conformance with the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.6.14 Access to Inner Tank

8.6.14.1 The inner tank must be provided with an access opening having a minimum inside diameter of 406 mm (16 in.). Reinforcement of the access opening must be made of the same material used for the inner tank.

8.6.14.2 If a welded closure is used, the closure must be designed to allow it to be reopened by grinding or chipping and to be closed again by re-welding without a need for new parts. A cutting torch must not be used.

8.6.15 Inner Tank Piping

8.6.15.1 In the case of piping lines for the liquid and gas phase of the refrigerated liquid:

a. the piping system or vapour and liquid-phase transfer and venting system must be made of materials that are compatible with the dangerous goods and that are suitable for use at the temperature of the dangerous goods;

b. the outlets of all vapour-phase and liquid phase lines must be located so that accidental discharge from the lines will not impinge on any metal of the outer jacket, car structures, trucks, or safety appliances; and

c. provision must be made to allow for thermal expansion and contraction.

8.6.15.2 In the case of loading and unloading lines:

a. a liquid-phase transfer line must be provided and it must have a manually-operated shut-off valve located as close as practicable to the outer jacket plus a secondary closure that is liquid-tight and gas-tight;

b. the secondary closure must permit any trapped pressure to bleed off before the closure can be removed completely;

c. a vapour trap must be incorporated into the line and located as close as practicable to the inner tank; and

d. on a Specification 113A60W tank car tank, any loading and unloading line must be vacuum-jacketed between the outer jacket and the shut-off valve and the shut-off valve must also be vacuum-jacketed.

8.6.15.3 In the case of a vapour-phase line:

a. the vapour-phase line must be connected to the inner tank and must be of sufficient size to permit the pressure-relief devices that are specified in clause 8.6.18 and that are connected to the vapour-phase line to operate at their design capacity without excessive pressure build-up in the tank;

b. the vapour-phase line must have a manually operated shut-off valve located as close as practicable to the outer jacket plus a secondary closure that is liquid-tight and gas-tight; and

c. the secondary closure must permit any trapped pressure to bleed off before the closure can be removed completely.

8.6.15.4 In the case of a vapour-phase blowdown line, the blowdown line must conform to the following requirements:

a. a blowdown line must be provided;

b. the blowdown line must be attached to the vapour-phase line specified in clause 8.6.15.3, upstream of the shut-off valve in that line;

c. a by-pass line with a manually operated shut-off valve must be provided to allow a reduction of the inner tank pressure when the vapour-phase line is connected to a closed system; and

d. the discharge from this line must be outside the housing and must be directed upward and away from operating personnel.

8.6.16 Pressure Testing of the Inner Tank

8.6.16.1 After all required items have been welded in place to the inner tank, the inner tank must be pressure-tested at the tank test pressure specified in clause 8.6.24.1.

8.6.16.2 The temperature of the pressurizing medium must be equal to or less than 37.8 °C (100 °F) during the test.

8.6.16.3 The inner tank must hold the specified tank test pressure for a period of not less than 10 min without evidence of yielding or leakage.

8.6.16.4 After a hydrostatic test, the inner tank and piping must be emptied of all water and purged of all water vapour.

8.6.16.5 Repairs to welded joints that have developed leaks during the test must be made in conformance with the requirements set out in Appendix W of the AAR *Specifications for Tank Cars* publication.

8.6.17 Valves and Gauges

8.6.17.1 Manually operated shut-off valves and control valves must be provided wherever needed for the control of vapour-phase pressure, vapour-phase venting, liquid transfer and liquid-flow rates.

8.6.17.2 Valves must conform to the following requirements:

a. All valves must be made from materials that are compatible with the dangerous goods and that are suitable for use at the temperature of the dangerous goods;

b. Liquid control valves must have an extended stem design;

c. Packing, if used, must be compatible with the dangerous goods and be of materials that will seal the valve stem without causing difficulty of operation; and

d. Each control valve and shut-off valve must be readily operable. These valves must be mounted so that their operation will not transmit excessive forces to the piping system.

8.6.17.3 Gauges must conform to the following requirements:

a. Gauges, except portable units, must be securely mounted within suitable protective housings;

b. A liquid-level gauge that indicates the quantity of liquid within the inner tank must be provided;

c. The liquid level gauge must be:

   i. a permanent gauge mounted where it will be readily visible during handling or storage;

   ii. a portable gauge with a readily accessible connection; or

   iii. a fixed length dip tube that:

      A. has a manually operated shut-off valve located as close as practicable to the outer jacket;

   - B. indicates the maximum liquid level for the allowable filling density; and
   - C. has the inner end of the dip tube located on the longitudinal centreline of the inner tank and within 1219 mm (48 in.) of the transverse centreline of the inner tank.

d. A vapour-phase pressure gauge that indicates the vapour pressure within the inner tank must be provided; and

e. The vapour-phase pressure gauge must:

   i. have a manually operated shut-off valve located as close as practicable to the outer jacket;

   ii. must be mounted where it will be readily visible; and

   iii. have an additional fitting for the use of a test gauge.

8.6.18 Pressure-relief Devices

8.6.18.1 General

The tank car tank and piping system of the tank car tank must be protected by the installation of pressure-relief devices and must conform to the following requirements:

a. the discharge from the pressure-relief devices must be directed away from operating personnel, principal load-bearing members, and attachments of the outer jacket, trucks, and safety appliances;

b. vent or weep holes in the pressure-relief devices are prohibited; and

c. all main pressure-relief devices must discharge to the outside of the protective housing in which they are located, except that this requirement does not apply to pressure-relief devices installed to protect isolated sections of lines between the final valve and the end closure.

8.6.18.2 Materials

Materials used in pressure-relief devices must be compatible with the dangerous goods and suitable for use at the temperature of the dangerous goods.

8.6.18.3 Inner Tank

The following requirements apply to the use of pressure-relief devices and safety vents for the inner tank:

a. Pressure-relief devices for the inner tank must be attached to vapour-phase piping and mounted so as to remain at ambient temperature before operation;

b. The inner tank must be equipped with one or more pressure-relief devices and one or more safety vents, except as provided in clause 8.6.18.3 e. iv., and installed without an intervening shut-off valve, except as provided in clause 8.6.18.3 e. iii.;

c. The safety vent must:

   i. function at the pressure specified in clause 8.6.24.1;

   ii. be flow-rated in conformance with the applicable requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication; and

iii. provide sufficient capacity to conform to the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication.

d. The pressure-relief device must:

  i. be set to start-to-discharge at the pressure specified in clause 8.6.24.1; and

  ii. conform to the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication;

e. Installation of Safety Vent and Pressure-relief Device

  i. Inlet Piping

    A. The opening through all piping and other service equipment between the inner tank and its pressure-relief devices must have a cross-sectional area equal to or greater than that of the pressure-relief device inlet and the flow characteristics of this upstream system must be such that the pressure drop will not adversely affect the relieving capacity or the proper operation of the pressure-relief device;

    B. If the required relief capacity is met by the use of a multiple pressure-relief device placed on one connection, the inlet internal cross-sectional area of this connection must be sufficient to provide the required flow capacity for the proper operation of the pressure-relief device system;

  ii. Outlet Piping

    A. The opening through the discharge lines must have a cross-sectional area equal to or greater than that of the pressure-relief device outlet and must not reduce the relieving capacity below that required to properly protect the inner tank;

    B. If the required relieving capacity is met by the use of multiple pressure-relief devices placed on a common discharge manifold, the manifold outlet internal cross-sectional area must be equal to or greater than to the combined outlet areas of the pressure-relief devices;

  iii. Duplicate pressure-relief devices may be used if a three-way selector valve is installed to provide for relief through either pressure-relief device. The three-way selector valve must be included in the mounting set out in par. A5.2.6 of the AAR *Specifications for Tank Cars* publication, when conducting the flow capacity test on the safety vent set out in par. A5.1 of the AAR *Specifications for Tank Cars* publication. Flow capacity tests must be performed with the three-way valve at both of the extreme positions as well as at the mid-position and the flow capacity must be in conformance with the requirements set out in Appendix A of the AAR *Specifications for Tank Cars* publication;

  iv. An alternate pressure-relief device in conformance with the requirements set out in clause 8.6.24.1 may be used in lieu of the safety vent, provided it conforms to the flow capacity set out in Appendix A of the AAR *Specifications for Tank Cars* publication at a flow rating pressure of 110% of its start-to-discharge pressure. Installation must:

A. prevent moisture accumulation at the seat by providing drainage away from that area;

B. permit periodic drainage of the vent piping; and

C. prevent accumulation of foreign material in the vent system;

f. Evaporation Control — The normal release of vaporized dangerous goods may be controlled with a pressure controlling and mixing device. A pressure controlling and mixing device is required on a Specification 113A60W tank car tank. Any pressure controlling and mixing device must:

i. be set to start to discharge at a pressure equal to or less than that specified in clause 8.6.24.1;

ii. have sufficient capacity to limit the pressure within the inner tank to that pressure specified in clause 8.6.24.1, when the discharge is equal to twice the normal venting rate during transport, with normal vacuum and the outer shell at 54.4 °C (130 °F); and

iii. prevent the discharge of a gas mixture greater than 50% of the lower flammability limit to the atmosphere under normal conditions of handling or transport;

g. Safety Interlock — If a safety interlock is provided for the purpose of allowing transfer of dangerous goods at a pressure greater than the pressure-control valve setting and less than the pressure-relief device setting, the design must be such that the safety interlock will not affect the discharge path of the pressure-relief device or safety vent at any time. The safety interlock must automatically provide an unrestricted discharge path for the pressure-control device at all times during transport.

8.6.18.4 Outer Jacket

The outer jacket must be provided with a suitable system to prevent build-up of annular space pressure to a pressure greater than 110 kPa (16 psi) or greater than the external pressure value for which the inner tank was designed, whichever is the lesser. The total relief area provided by the system must be equal to or greater than 16 129 mm^2 (25 in.^{2}) and means must be provided to prevent clogging of any system opening and to provide for adequate communication to all areas of the insulation space. If a safety vent is a part of the system, it must be designed to prevent distortion of the rupture disc when the annular space is evacuated.

8.6.18.5 Piping System

If a piping circuit can be isolated by closing a valve, means for relieving any trapped pressure must be provided.

8.6.19 Test of Pressure-relief Valves

Each valve, before being put into service, must be tested with air or another gas for conformance with the requirements set out in clause 8.6.24.1.

8.6.20 (RESERVED)

8.6.21 Operating Instructions

8.6.21.1 All valves and gauges must be clearly identified with corrosion-resistant nameplates

8.6.21.2 A plate of corrosion-resistant material bearing precautionary instructions for the safe operation of the equipment during handling operations must be securely mounted so as to be readily visible.

8.6.21.3 The instruction plate must be mounted in each housing that contains service equipment and controls.

8.6.21.4 The precautionary instructions on the plate must include a diagram of the tank and its piping system with the various gauges, control valves, and pressure-relief devices clearly identified and located.

8.6.22 Permanent Markings

Subject to clause 7.3 the marking on a Specification 113 tank car tank must conform to the following requirements:

8.6.22.1 Each tank must have permanent markings, including:

a. tank specification;

b. design service temperature;

c. material specification of the inner tank;

d. as-built thickness of the shell and heads of the inner tank;

e. inside diameter;

f. inner tank manufacturer's identifying mark;

g. month and year of the original tank test of the inner tank;

h. water capacity of the inner tank;

i. material specification of the outer jacket;

j. initials assigned to the outer jacket manufacturer; and

k. identifying mark of the tank car assembler if different from the inner tank or outer jacket manufacturer.

8.6.22.2 The permanent markings must be stamped in the order set out in clause 8.6.22.1 in letters and figures equal to or greater than 9.53 mm (3/8 in.) in height into the metal near the centre of the head of the outer shell located at the B-end of the tank car. The inner container heads must not be stamped. The following is an example of the required markings:

TC 113A60W

-423°F

Inner/Intér. ASTM A240 304L

Head/Tête 3/16 in./po
Shell/Coque 3/16 in./po
ID/DI 107 in./po
Inner/Intér. ABC
12-2010
000000 lb/lb
Outer/Extér. ASTM A516–70
Outer/Extér. PQR
Assembler/Assembleur DEF

8.6.23 Stencilling

Each tank car must be stencilled in conformance with the requirements set out in Appendix C of the AAR *Specifications for Tank Cars* publication. The stencilling must include the following information:

a. The date on which the rupture disc was last replaced and the initials of the person making the replacement, on the outer jacket in letters and figures equal to or greater than 38.1 mm (1.5 in.) in height;

b. The design service temperature and maximum dangerous goods mass, adjacent to the dangerous goods identification stencil in letters and figures equal to or greater than 38.1 mm (1.5 in.) in height;

c. The water capacity, in kilograms but may include pounds at 15.6 °C (60 °F), with the tank at its coldest operating temperature and after deduction for the volume above the inlet to the pressure-relief device or pressure-control valve, structural members, baffles, piping, and other service equipment inside the tank, in letters and figures equal to or greater than 38.1 mm (1.5 in.) in height;

d. The statement "DO NOT HUMP OR CUT OFF WHILE IN MOTION" or "DO NOT HUMP OR CUT OFF WHILE IN MOTION / DÉFENSE DE PASSER SUR LA BUTTE DE TRIAGE OU DE DÉTELER EN MOUVEMENT," on both sides of the tank car, in letters equal to or greater than 38.1 mm (1.5 in.) in height; and

e. The statement "VACUUM-JACKETED" or "VACUUM-JACKETED / CHEMISE SOUS VIDE," on the outer jacket below the specification stencil, in letters equal to or greater than 38.1 mm (1.5 in.) in height.

8.6.24 Individual Specification Requirements Applicable to Inner Tanks and Service Equipment for TC Specification 113 Vacuum-insulated Tank Car Tanks for Cryogenic Liquids

8.6.24.1 Individual Specification Minimum Requirements

In addition to requirements set out in clause 8.6.1, the inner tank and service equipment for a tank car for cryogenic liquids must conform to the individual TC Specification requirements corresponding to the specification set out in the following table:

TC Specification	113A60W	113C120W	113C140W	113A90W
Design service temperature	–252.8 °C (-423 °F)	-162.2°C (-260°F)	-162.2°C (-260°F)	-195.5°C (-320°F)
Materials	Clause 8.6.4	Clause 8.6.4	Clause 8.6.4	Clause 8.6.4
Impact test (weld and plate material)	Clause 8.6.4.3	Clause 8.6.4.3	Clause 8.6.4.3	Clause 8.6.4.3
Impact test values	Clause 8.6.4.4	Clause 8.6.4.4	Clause 8.6.4.4	Clause 8.6.4.4
Standard heat transfer rate, kJ/day/kg (Btu/day/lb) of water capacity, maximum (see clause 8.6.3)	0.2256 (0.097)	0.9585 (0.4121)	0.9585 (0.4121)	1.163 (0.5)
Tank burst pressure, minimum, kPa (psi)	1654 (240)	2068 (300)	2482 (360)	1654 (240)
Plate thickness shell, minimum, mm (in.) (see clause 8.6.7.1)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)
Head thickness, minimum, mm (in.) (see clause 8.6.6)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)	4.76 (3/16)
Tank test pressure, kPa (psi) (see clause 8.6.16)	414 (60)	827 (120)	965 (140)	621 (90)
Safety vent bursting pressure, maximum, kPa (psi)	414 (60)	827 (120)	965 (140)	621 (90)
Pressure-relief device start-to-discharge pressure ±20 kPa (±3 psi)	207 (30)	517 (75)	621 (90)	414 (60)
Pressure-relief device vapour-tight pressure, minimum, kPa (psi)	165 (24)	414 (60)	496 (72)	331 (48)
Pressure-relief device flow rating pressure, maximum, kPa (psi)	276 (40)	586 (85)	689 (100)	455 (66)

TC Specification	113A60W	113C120W	113C140W	113A90W
Alternate pressure-relief device start-to-discharge pressure, ±20 kPa (±3 psi)	—	621 (90)	745 (108)	496 (72)
Alternate pressure-relief device vapour-tight pressure, minimum, kPa (psi)	—	496 (72)	593 (86)	400 (58)
Alternate pressure-relief device flow rating pressure, maximum, kPa (psi)	—	689 (100)	827 (120)	552 (80)
Pressure-control valve start-to-vent, maximum, kPa (psi) (see clause 8.6.18.3 f.)	117 (17)	Not required	Not required	Not required
Relief device discharge restrictions	Clause 8.6.18	Clause 8.6.18	Clause 8.6.18	Clause 8.6.18
Transfer line insulation	Clause 8.6.15	Not required	Not required	Not required

9 QUALIFICATION AND MAINTENANCE OF TANK CARS AND TON CONTAINERS

9.1 Scope

The requirements specified in this section apply to any person who qualifies, modifies, marks, handles, or maintains tank cars or ton containers in Canadian service.

9.2 General Requirements

9.2.1 Tank Cars

A tank car facility or person performing a function on a tank car must comply with the requirements of the owner concerning qualification and maintenance and the applicable requirements of this standard and of the AAR *Specifications for Tank Cars* publication. In case of conflict, the requirements of this standard apply.

9.3 Tank Car Qualification

Unless otherwise specified in this section and for the purpose of tank car qualification, column 2 of the following table indicates the inspections and tests that are required for the corresponding qualification item of column 1.

Qualification Items	Inspections and Tests
Tank car	Visual inspection Structural integrity inspection Safety systems inspection
Thickness	Thickness test
Service equipment	Service equipment inspection Leak testing
Lining or coating	Lining or coating inspection
Stub sills	Stub sill inspection

9.4 Requirements for Qualification and Maintenance of Tank Car Stub Sills

9.4.1 Inspections

All tank cars of stub sill design must receive inspections of the stub sills by a tank car facility at the time of manufacture and periodically thereafter to ensure structural integrity of the sills, using inspection procedures specified in clause 9.4.3.

9.4.2 Intervals

The inspection interval must not exceed 10 years, nor the interval established for the tank structural integrity inspection. Inspections must occur no later than when:

a. the tank car reaches 321 869 km (200 000 miles) from the build date or the last stub sill inspection or

b. the tank car reaches 804 672 km (500 000 miles) from the build date or the last stub sill inspection, if the stub sill is designed and built to equal or greater than the one-million mile fatigue life requirement.

Inspections must be performed at shorter intervals when a reliability assessment of a stub sill design indicates a tendency to rapidly develop rejectable defects.

9.4.3 Inspection procedures and records

9.4.3.1 The inspections must include all weld attachments of stub sill-to-pad, stub sill-to-head brace (if used), bolster-to-sill, and head brace-to-pad. Inspections must be made both inboard and outboard of the body bolster.

9.4.3.2 The inspections must include the surfaces of the sill top flange, sill webs, sill bottom flanges and sill pads in the vicinity of the attachment welds referred to in clause 9.4.3.1 for the presence of parent metal cracks and fractures or other significant damage both inboard and outboard of the body bolsters.

9.4.3.3 Inspection personnel, procedures and techniques for attachment welds must conform to Appendix T of the AAR *Specifications for Tank Cars* publication.

9.4.3.4 Appropriate inspection ports must be provided in jackets and head shields and other equipment removed, such as draft gear as required to provide sufficient access for adequate inspections. Welds and other surfaces as required must be cleaned and made accessible consistent with the inspection method and technique requirements.

9.4.3.5 The year in which a stub sill inspection is performed and the inspection due date must be applied in the location specified on the qualification stencil (Fig. C.5 or Fig. C.9 of the AAR *Specifications for Tank Cars* publication) in numerals at least 25.4 mm (1 in.) in height. A code indicating the tank car facility having performed the inspection must also be applied.

9.4.3.6 Results of inspections must be documented and kept by the tank car owner throughout the period of ownership of the tank car plus one year after a change of ownership. The stub sill inspection report must be transmitted electronically to the AAR's electronic database (TCID), referred to in par. R.1.1.2 of the AAR *Specifications for Tank Cars (M-1002)* publication, or other reporting approved by the Executive Director.

9.4.4 Maintenance, Modification and Repairs

Repairs to parent metal cracks in stub sill structural components or attachment welds referred to in clause 9.4.3.1 must be performed in accordance with AWS D15.1. Repairs must be performed in accordance with the tank car owner's documentation and procedures.

9.4.5 Acceptable Results of Stub Sill Inspection

A tank car successfully passes the stub sill inspection if the inspection reveals no visible parent metal crack or other defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.5 Requirements for Qualification of Tank Cars

9.5.1 Owner's Responsibilities, General

An owner of a tank car, a lining or coating, or service equipment is responsible for:

a. qualifying the tank car including stub sills as per clause 9.4, the lining or coating, or the service equipment in conformance with the requirements set out in this section;

b. scheduling and the performance of inspections and tests of the tank car including stub sills, the lining or coating, or the service equipment;

c. developing, implementing, and evaluating a qualification program for the tank car including stub sills, the lining or coating, or the service equipment;

d. validating and specifying the methods and procedures for the non-destructive examination of the tank car including stub sills, the lining or coating, or the service equipment. Such methods and procedures must be adequate to detect defects and conditions that could compromise the reliability of the tank car, the lining or coating, or the service equipment; and

e. developing the documentation relative to the requirements set out in this section.

9.5.2 Owner's Responsibilities Regarding Tank Car Facilities

An owner of a tank car, lining or coating, or service equipment is responsible for ensuring that each tank car facility complies with the owner's qualification program developed in accordance with the requirements of this section, through periodic analysis and surveillance of the qualification activities of the tank car facility, including:

a. inspection and testing of the tank car including stub sills, the lining or coating, or the service equipment in accordance with the requirements set out in clause 9.5;

b. evaluating the results of inspections and tests in accordance with the requirements related to qualification set out in clause 9.6;

c. marking of the tank car in accordance with the requirements set out in clause 7.4; and

d. preparing of the documentation in accordance with the requirements set out in clause 9.8.

The tank car owner is responsible for overseeing the entire qualification program of the tank car. The tank car owner, lining or coating owner and service equipment owner must facilitate the communication of pertinent tank car information regarding the tank car's qualification between all concerned parties.

9.5.3 Responsibilities of Tank Car Facility

A tank car facility must obtain the permission of the equipment owner before performing work affecting modification, repair, or qualification of the owner's equipment. For the purposes of qualification and maintenance, the tank car facility must use the written instructions, respecting all applicable requirements, furnished by the owner or have written confirmation from the owner allowing the use of written instructions furnished by another. A tank car facility must report all work performed to the owner. The tank car facility must also report observed damage, deterioration, failed components, or non-compliant parts to the owner.

9.5.4 Qualification of Tank Cars

9.5.4.1 The maximum interval for inspection and tests shall not exceed the requirements set out in column 3 of the following table for each corresponding inspection and test set out in column 2, except where an adjustment is required in clauses 9.5.13.1 and 9.5.13.2.

Qualification of	Inspections and Tests	Maximum Interval (years)	Reference
Tank	Visual inspection	10	Clause 9.5.6
	Structural integrity inspection	10	Clause 9.5.7
	Thickness test	10	Clauses 9.5.8 and 9.5.9
	Safety systems inspection	10	Clause 9.5.10
Coating/Lining	Lining or coating inspection, for lining or coating applied for the protection of the tank	as per clause 9.5.11	Clause 9.5.11
Service Equipment	Service equipment inspection	10	Clause 9.5.12
Stub Sills	Stub sill inspection	as per clause 9.4	Clause 9.4

9.5.4.2 The inner container of a Specification 115 tank car must have a hydrostatic tank test conforming to the applicable requirements set out in clause 8.4.20 of this standard and par. D4.2 of the AAR *Specifications for Tank Cars* publication at a maximum interval of ten years. The hydrostatic test pressure must be equal to or greater than the specification test pressure of the tank car tank.

9.5.4.3 For a tank car designed for cryogenic liquids, including a Specification 113 or AAR 204W tank car, only the following minimum inspections and tests and maximum intervals apply:

a. a visual inspection of the exterior surface of the outer shell in conformance with the requirements set out in clauses 9.2.1 and 9.5.6.a, at a maximum interval of ten years;

b. a visual inspection in conformance with the requirements set out in clauses 9.2.1 and 9.5.6.c., d., e., f., and h. at a maximum interval of ten years;

c. a structural integrity inspection in conformance with the requirements set out in clauses 9.2.1 and 9.5.7.1 at all locations susceptible to damage that could compromise the reliability of the tank car, at a maximum interval of ten years. At a minimum, the inspection must include:

- i. all outer shell transverse fillet welds with dimensions greater than 6.35 mm (1/4 in.) within 1219 mm (48 in.) of the bottom longitudinal centerline, except body bolster pad attachment welds;
- ii. the termination of longitudinal fillet welds with dimensions greater than 6.35 mm (1/4 in.) within 1219 mm (48 in.) of the bottom longitudinal centerline on the outer shell; and
- iii. the non-reinforced exposed outer shell butt welds within 610 mm (24 in.) of the bottom longitudinal centerline.

d. a service equipment inspection in conformance with the requirements set out in clauses 9.2.1 and 9.5.12 at a maximum interval of ten years, except that the maximum interval for pressure-relief valves on specification 113 tank cars is five years; and

e. a stub sill inspection in conformance with the requirements set out in clause 9.4.

9.5.4.4 All qualification requirements need not be performed at the same time.

9.5.4.5 Pressure-relief devices on tank cars used in the handling, offering for transport or transporting of anhydrous ammonia must be qualified at an interval not exceeding five years. Non-coated carbon steel springs must be replaced with a stainless steel spring or a spring coated to protect against ammonia stress corrosion cracking, at the time of qualification.

9.5.5 Other Conditions Requiring Inspections and Tests

Before a tank car is used in the handling, offering for transport, or transporting of dangerous goods and despite the maximum intervals for qualification set out in the table of clause 9.5.4.1, the owner of the tank car or the lining or coating is responsible for:

a. the performance of a visual inspection, a structural integrity inspection in conformance with the requirements set out in clauses 9.5.6 and 9.5.7, and any other appropriate inspection and test in conformity with this section, if the tank car shows evidence of structural damage or has been subjected to loads in excess of its design requirements;

b. the performance of a visual inspection and thickness test in conformance with the requirements set out in clauses 9.5.6 and 9.5.8, and any other appropriate inspection and test in conformance with this section, if the tank car shows evidence of damage caused by fire;

c. the performance of a lining or coating inspection in conformance with the requirements set out in clause 9.5.11 if the lining or coating that was applied for the protection of the tank:

- i. has failed;
- ii. was put in contact with a product not compatible with the lining or coating; or

   iii. was subjected to a temperature outside the service temperature range of the lining or coating; and

d. a tank car that has been used for dangerous goods with a primary or subsidiary classification of Class 8 must not be used in the handling, offering for transport or transporting of Class 2 dangerous goods unless the tank car is qualified in accordance with the requirements set out in this section.

9.5.6 Visual Inspection

At a minimum, the visual inspection performed under this section must include the following items for the purpose of detecting defects or other conditions that could compromise the reliability of the tank car:

a. Subject to clause 9.5.6.i, the interior and exterior surface of the tank car tank, except in areas where an insulation system, a safety system, or an internal lining or coating precludes inspection;

b. The internal surface of the tank car tank after removing an interior lining or coating or before applying a new lining or coating;

c. The service equipment, including gaskets;

d. Fasteners;

e. All bolted, threaded, and quick-coupling closures and their fasteners;

f. Protective housings;

g. Excess-flow valves with threaded seats, including an inspection for tightness and operability;

h. Compliance markings required by the standard for legibility and correctness; and

i. For a Specification 115 tank car, the interior of the inner container and the exterior shell and heads.

9.5.7 Structural Integrity Inspection

9.5.7.1 The structural integrity inspection must be performed by using one or more of the non-destructive evaluation methods set out in Table T2 of the AAR *Specifications for Tank Cars* publication.

9.5.7.2 At a minimum, the structural integrity inspection must include all of the locations susceptible to damage that could compromise the reliability of the tank car tank, nozzles, welds, and welded attachments, including:

a. all transverse fillet welds with dimensions greater than 6.35 mm (1/4 in.) within 1219 mm (48 in.) of the bottom longitudinal centreline, except body bolster pad attachment welds;

b. the termination of longitudinal fillet welds with dimensions greater than 6.35 mm (1/4 in.) within 1219 mm (48 in.) of the bottom longitudinal centreline; and

c. the tank shell butt welds within 610 mm (24 in.) of the bottom longitudinal centreline unless the tank car owner can determine by analysis, such as damage tolerance analysis and finite element stress analysis that the tank car will not develop defects or other conditions that could compromise its reliability. The analysis must include a determination of the probable locations and modes of damage to the tank car due to fatigue, corrosion, or accidental damage. As an alternative, service reliability assessment may be used, provided it is supported by analysis of systematically collected data.

9.5.7.3 For a Specification 115 tank car, clause 9.5.7.2 applies only to the outer shell fillet welds and to the non-reinforced, exposed, outer shell butt welds.

9.5.7.4 In the case of tank cars with a lining, the inspection requirements of clause 9.5.7.2.c do not apply to a tank shell butt weld covered on the outside by a reinforcing plate or any other structural element welded to the tank shell until the time of lining removal or application.

9.5.7.5 In the case of a tank car with an internal patch plate, the structural integrity inspection requirements of this clause do not apply to a tank shell butt weld covered on the inside by the patch plate and on the outside by a reinforcing plate or any other structural element welded to the tank shell.

9.5.8 Thickness Test

9.5.8.1 The equipment and procedures used to measure thickness must be capable of an accuracy of ±0.05 mm (±0.002 in.).

9.5.8.2 At a minimum, the thickness test must include measurement of the tank wall thickness at the shell and heads, sumps, nozzles, and nozzle reinforcing pads.

9.5.8.3 Subject to clause 9.5.8.4, the thickness test must be performed at the following intervals:

a. subject to clauses 9.5.8.3.b. and 9.5.8.3.c., at least once every ten years;

b. at the time of applying or replacing a lining or coating; or

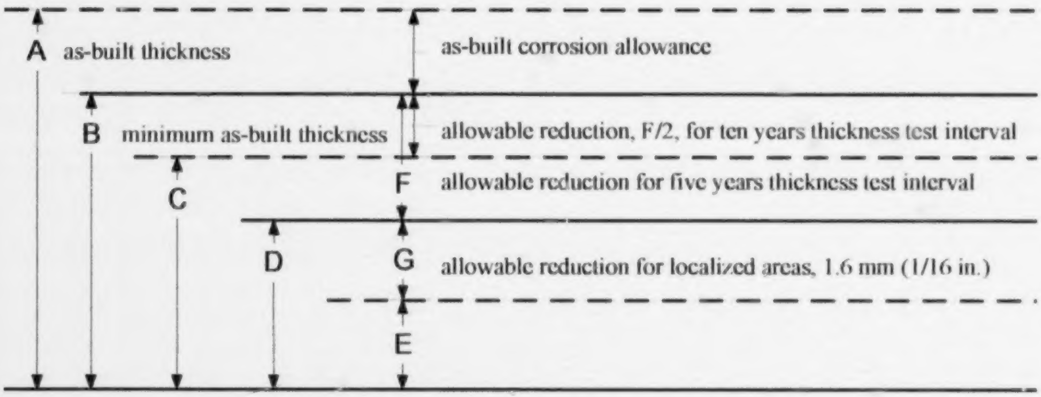
c. at least once every five years if:

   i. the tank does not have a lining or a coating;

   ii. the tank car is used in the handling, offering for transport, or transporting of dangerous goods that are corrosive to the tank; and

   iii. the remaining shell and head thickness of the tank is at or below line C of Figure 9.5.8 c.

FIGURE 9.5.8 c. - Thickness Reduction Limits for Unlined/Uncoated Tank Cars in Corrosive Service


A as-built thickness
as-built corrosion allowance
B minimum as-built thickness
allowable reduction, F/2, for ten years thickness test interval
C
F allowable reduction for five years thickness test interval
D
G allowable reduction for localized areas, 1.6 mm (1/16 in.)
E

where:

A = as-built tank shell or head thickness

B = design minimum tank shell or head thickness, after forming, as set out in section 8

C = inspection frequency adjustment point calculated by subtracting half the value found in the table entitled Allowable Thickness Reductions, as set out in clause 9.5.9 from B, the minimum as-built thickness

D = limit for shell or head thickness (design minimum shell or head thickness minus the allowable shell thickness reduction as set out in clause 9.5.9)

E = limit for shell or head localized thickness (design minimum shell or head thickness minus both the allowable shell thickness reduction as set out in clause 9.5.9 and 1.6 mm [1/16 in.])

F = allowable shell or head thickness reduction as set out in clause 9.5.9

G = additional thickness reduction for localized shell or head areas as set out in clause 9.5.9

9.5.8.4 A thickness test must be performed to verify conformance with the requirements set out in clause 9.5.9 if a material corrosive to the tank has contacted the tank wall and a localized repair of a lining or coating applied for the protection of the tank is performed. The thickness test applies only to the repaired area.

9.5.8.5 Thickness reductions in sumps, nozzles and nozzle reinforcing pads must not cause a condition or release of dangerous goods from the tank car that could endanger public safety or compromise their reliability.

9.5.8.6 After any modification or maintenance activity that results in a reduction of the wall thickness of a tank car, a thickness test must be performed in the areas affected by the reduction.

9.5.8.7 A tank car with a lining or coating must be marked with "LNG RMVL" as the test due date to indicate that the thickness test is required at the time of lining removal or replacement.

9.5.9 Allowable Thickness Reductions

The allowable thickness reductions of a tank shell and head are specified in the following table. Subject to clauses 9.5.9.1 to 9.5.9.3, a tank car tank with a thickness below the minimum thickness specified in section 8 may continue in service provided any reduction to the design minimum thickness is not greater than the reductions specified in columns 2 and 3 corresponding to the tank test pressures specified in column 1.

Tank Test Pressure, TP kPa (psi)	Top Shell and Tank Head mm (in.)	Bottom Shell mm (in.)
414 (60) ≤ TP < 1379 (200)	3.18 (1/8)	1.59 (1/16)
TP ≥ 1379 (200)	0.794 (1/32)	0.794 (1/32)

9.5.9.1 An extra 1.59 mm (1/16 in.) may be added to the values in the table for local reductions. Local reductions are those that do not exceed twenty linear centimetres (eight linear inches), measured at the longest dimension, and are separated from any other local reduction by at least 406 mm (16 in.).

9.5.9.2 The structural strength of the tank must not be affected by any reduction in the tank car tank wall thickness to the extent that the tank car structure is no longer capable of withstanding the minimum loads and stresses to which it was designed.

9.5.9.3 Shell thickness reductions apply only to the outer shell for Specification 115 tank cars. There is no reduction below the design minimum thickness authorized for the inner container.

9.5.10 Safety Systems Inspection

A safety systems inspection must include all safety systems. A safety systems inspection must ensure that all the systems conform to their design requirements and must be adequate to detect defects or other conditions that could compromise the reliability of the safety system. An inspection is not required for a foam or cork insulation system or an insulation system that does not meet the definition of a safety system or that has not been taken into account when establishing the pressure relief devices minimum flow capacities.

9.5.10.1 Acceptable Level of Defects in Thermal Protection Systems

a. The maximum permissible void size or total void area is described in the following table:

Void	Size / Area	Condition
Single isolated void	Maximum allowable void is 1219 mm (48 in.) on the longitudinal axis of the tank by 406 mm (16 in.) on the circumferential axis	Voids must be separated from other voids by more than one half of the largest dimension or must be considered a single void.
Total void area	Maximum allowable total void area is 9% of the total tank surface area.	

b. The inspection method, technique and procedure must be capable of detecting single square voids of 406 mm (16 in.) X 406 mm (16 in.) at any location on the tank car tank surface.

c. Areas of defects other than voids, such as deteriorated thermal protection material, significantly reducing the thermal performance of the material must be considered the same as voids.

9.5.11 Lining or Coating Inspection

9.5.11.1 For the purpose of this clause, commodity pairing means a specific lining or coating that is used in combination with specific dangerous goods.

9.5.11.2 At a minimum, a lining or coating applied for the protection of the tank must have a lining or coating inspection that is adequate to detect defects or other conditions that could compromise the reliability of the lining or coating.

9.5.11.3 The owner of the lining or coating must monitor and maintain a record of the performance of the commodity pairings. The owner of the lining or coating must determine an appropriate lining and coating inspection interval based on the knowledge and experience of the lining or coating owner with respect to the commodity pairing and the information in the records.

9.5.11.4 The inspection interval must be established by the owner of the lining or coating through documentation and scientific analysis of the commodity pairing so that the coating or lining inspection interval would not compromise the reliability of the tank car. The owner of the lining or coating must also take measures to prevent corrosion when possible.

9.5.11.5 Any person who offers for transport dangerous goods in a tank car must provide, upon request by the owner of the lining or coating or the owner of the tank car, commodity pairing information to the requesting party.

9.5.11.6 The owner of the lining or coating must provide the inspection procedures and the acceptance criteria for the lining or coating to the tank car owner and to the tank car facility responsible for qualifying the lining or coating. The tank car facility responsible for inspecting the lining or coating must follow the qualification requirements established by the owner of the lining or coating.

9.5.12 Service Equipment Inspection

9.5.12.1 At a minimum, the service equipment inspection must ensure that all of the service equipment conforms to the requirement set out in this standard and be adequate to detect defects or other conditions that could compromise their reliability.

9.5.12.2 Procedures for the inspection and testing of service equipment, including heater systems and pressure-relief devices must conform to the requirements set out in Appendix D of the AAR *Specifications for Tank Cars* publication.

9.5.12.3 The tank, service equipment, and closures installed, replaced or reinstalled must be leak tested in accordance with clause 9.7.3.

9.5.13 Adjustments in Inspection and Test Protocols

9.5.13.1 Each tank car owner must implement a system for the continuing analysis and surveillance of the performance and effectiveness of their inspection and maintenance programs. This system must include a means for the collection and analysis of data relative to the inspection and maintenance requirements set out in this section.

9.5.13.2 The tank car owner must use the collected data to evaluate the maintenance program, inspection intervals and tank car including stub sills, attachments to the bottom shell, service equipment, and lining or coating designs for the purpose of determining appropriate action for the minimization of failure, damage, and deterioration that could compromise the reliability of the tank car.

9.5.13.3 The maximum inspection intervals must not be increased and the qualification requirements set out in clause 9.5.4 must not be reduced unless an equivalency certificate regarding an increase in inspection interval or a reduction in qualification requirements has been issued in conformance with the requirements of the TDG Regulations.

9.5.13.4 When seeking a modification to the interval or requirements of a structural integrity inspection, an owner must provide an engineering analysis, such as damage tolerance analysis or finite element stress analysis. The analysis must include a determination of the probable locations and modes of damage to the tank car due to fatigue, corrosion, or accidental damage. As an alternative, service reliability assessment may be used, provided it is supported by analysis of systematically collected data.

9.5.14 (RESERVED)

9.6 Acceptable Results of Inspections and Tests

9.6.1 Qualification

A tank car is qualified if it successfully passes the inspection and test requirements set out in this section.

9.6.2 Visual Inspection

A tank car successfully passes the visual inspection if the inspection reveals no defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.3 Structural Integrity Inspection

A tank car successfully passes the structural integrity inspection if the inspection reveals no visible parent metal crack or other defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.4 Thickness Test

A tank car successfully passes the thickness test when the tank shell and heads show no thickness reduction greater than that specified in clause 9.5.9.

9.6.5 Safety System Inspection

A tank car successfully passes the safety system inspection if each safety system of the tank car, including:

a. a thermal protection system;

b. a tank-head puncture-resistance system;

c. a coupler vertical restraint system;

d. an insulation system used to control pressure or outage; or

e. a system used to protect top or bottom discontinuities;

conforms to the requirements set out in this standard including clause 8.3.19 or a special provision of schedule 1 for insulation systems and the inspection reveals no defect larger than the limits specified in clause 9.5.10.1 or that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.6 Lining or Coating Inspection

A tank car successfully passes the lining and coating inspection if the inspection reveals no defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.7 Service equipment

A tank car successfully passes the service equipment inspection when the equipment conforms to this standard and the applicable provisions of Appendix D of the AAR *Specifications for Tank Cars* publication and the inspection reveals no defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.6.8 Tank Test

A Specification 115 tank car successfully passes the tank test if the tested tank does not show evidence of yielding, leakage or other defect that may reasonably be expected to cause, before the next inspection is due and under normal conditions of transport, including handling, a condition or release of dangerous goods that could endanger public safety.

9.7 Maintenance

9.7.1 Periodic Analysis and Surveillance

An owner of a tank car, lining or coating, or service equipment is responsible for ensuring that each tank car facility conforms to the owner's maintenance program through periodic analysis and surveillance of the maintenance activities of the tank car facility.

9.7.2 Coating of Tank Exterior and Jacket Interior

If the jacket of a tank car is completely removed for maintenance purposes, the exterior surface of the tank car tank and the interior surface of the tank car jacket must have a protective coating applied or renewed if either of these surfaces is found to be inadequately protected against corrosion.

9.7.3 Leak Testing

9.7.3.1 Subject to clause 11.4.1, a successful leak test conforming to Appendix T of the AAR *Specifications for Tank Cars* publication is required at the time of service equipment qualification or after any modification or any maintenance activity involving the removal of any service equipment, unless the tank car service equipment arrangement precludes it. The leak test must verify that service equipment closures, including auxiliary devices when so equipped and its connection to the tank car tank do not leak. The leak test must be performed on a tank car with all service equipment in place and functional.

9.7.3.2 In addition to the requirements of clause 9.7.3.1, maintenance and qualification of service equipment, involving resealing, rebuilding or remanufacturing must conform to Appendices D and T of the AAR *Specifications for Tank Cars* publication.

9.7.3.3 A leak test is not required when a pressure-control valve or a pressure-relief valve on a tank car transporting a cryogenic liquid, or a pressure-regulating valve on a tank car transporting carbon dioxide, has leaked because of ice build-up and is subsequently made to reseat properly.

9.7.4 Exception to Leak Testing

A leak test is not required if the removal of the service equipment is for the sole purpose of loading or unloading the dangerous goods and the service equipment is designed for loading or unloading, including the removal of pipe plugs and caps, quick disconnects and their closures, hinged manway covers, and fill hole covers.

9.7.5 Access Openings in Jackets and Tank-head Puncture-resistance Systems

a. When sections of tank-head puncture-resistance systems are cut out for any reason, the sections must be replaced using a full penetration weld or other method approved by the Executive Director, to restore the full strength of the original system.

b. When sections of the tank jacket are cut out for any reason, the sections must be replaced to restore the original integrity, and made weather-tight.

c. When sections of thermal protection are removed for any reason, the sections must be replaced with a system providing equivalent thermal performance and fire resistance.

9.8 Reporting and Record Retention Requirements

9.8.1 Certification and Representation

The manufacturer of a tank car must certify that all of the requirements set out in this standard, including inspections and tests that are required for the qualification of the tank car, have been performed by signing the Certificate of Construction, Form AAR 4-2, and by marking the tank with the appropriate tank car specification to which the tank car was manufactured. The manufacturer must retain the reports relating to the manufacture and qualification of the tank car. The owner of the tank car must retain, throughout the period of ownership of the tank car plus one year after the change of ownership, the Certificate of Construction and any documents relating to subsequent approvals, which certify that the tank car identified in the documentation conforms to the requirements set out in the applicable specification.

9.8.2 Qualification and Stub Sill Inspection Reporting

A written or electronic report must be provided for a tank car that has been inspected or qualified in conformance with the requirements set out in this section. The owner of the tank car must retain a copy of the report until the next qualification or stub sill inspection record has been produced. The report must include the following information:

a. Inspection or qualification items;

b. The results for each inspection or qualification item;

c. Tank car reporting mark and number;

d. Tank car specification;
e. Qualification date for each qualification item;
f. Inspection date;
g. Location and description of defects and method used to repair each defect;
h. The name and address of the tank car facility and the name of the inspector; and
i. The facility registration symbol.

The stub sill inspection report must be transmitted electronically to the AAR in accordance with clause 9.4.3.6

9.9 Periodic Retest and Inspection of Ton Containers

9.9.1 General

A ton container and its pressure-relief devices must be inspected and retested periodically in conformance with the requirements set out in this clause.

9.9.2 Inspection and Tests

9.9.2.1 Subject to clause 9.9.2.8, a ton container must be subjected to the specified hydrostatic pressure and its permanent expansion must be determined by a method that conforms to the requirements set out in CGA Publication C-1 except that the use of a calibrated cylinder or ton container may be substituted with an alternative method for test system accuracy verification. A ton container successfully passes a hydrostatic pressure test when the permanent volumetric expansion does not exceed 10% of the total volumetric expansion at the test pressure and the ton container does not show evidence of yielding or leakage.

9.9.2.2 Subject to clause 9.9.2.8, and in addition to the hydrostatic pressure test requirements of clause 9.9.2.1, a ton container must be subjected to an air-pressure test at a pressure equal to or greater than 689 kPa (100 psi) under conditions favourable to the detection of any leakage. A ton container successfully passes an air-pressure test when there is no evidence of yielding or leakage.

9.9.2.3 An internal and external visual inspection must be performed. A ton container successfully passes the visual inspection if it meets the criteria set out in CGA Publication C-6.

9.9.2.4 A reclosing pressure-relief device must be tested by pressurizing with air or other gas. A reclosing pressure-relief device installed on a ton container must conform to the requirements set out in column 5 and column 6 of the Retest Table of clause 9.9.2.6. A reclosing pressure-relief device successfully passes the test if the measured start-to-discharge pressure of the device is at or below the specified start-to-discharge pressure and the measured vapour-tight pressure is at or above the specified vapour-tight pressure.

9.9.2.5 Rupture discs and fusible plugs must be removed from the tank and visually inspected.

9.9.2.6 Subject to clause 9.9.2.6.1 a ton container must be retested as specified in the following table.

Specification	**Maximum Retest Interval years**		**Retest Pressure kPa (psi)**	**Specified Pressure for Reclosing Pressure-relief Device kPa (psi)**	
	Tank	**Pressure-relief Device**	**Hydrostatic Pressure Test**	**Start-to-discharge**	**Vapour-tight**
106A500	5	2	3447 (500)	2586 (375)	2068 (300)
106A500X	5	2	3447 (500)	2586 (375)	2068 (300)
106A800	5	2	5516 (800)	4137 (600)	3309 (480)
106A800X	5	2	5516 (800)	4137 (600)	3309 (480)
106A800NCI	5	2	5516 (800)	4137 (600)	3309 (480)
110A500W	5	2	3447 (500)	2586 (375)	2068 (300)
110A600W	5	2	4137 (600)	3103 (450)	2482 (360)
110A800W	5	2	5516 (800)	4137 (600)	3309 (480)
110A1000W	5	2	6895 (1000)	5171 (750)	4137 (600)

9.9.2.6.1 Pressure-relief devices of the spring-loaded type on tanks used exclusively for fluorinated hydrocarbons that do not contain components that are corrosive to the tank or to the pressure-relief device may be retested every five years.

9.9.2.7 The month and year of the inspections and tests performed in conformance with the requirements set out in clause 9.9 must be plainly and permanently stamped into the metal of one head or chime of each ton container which successfully passes the periodic retest and inspection; for example, "01-12" for a retest and inspection performed in January of 2012. If the ton container was visually inspected in conformance with the requirements set out in clause 9.9.2.8 and the pressure tests set out in clauses 9.9.2.1 and 9.9.2.2 were not performed, the month and date of the retest and inspection must be followed by a "V"; for example, "01-12 V" for a visual inspection performed in January of

2012. Dates of previous retests and inspections and all specified markings must be kept legible.

9.9.2.8 In the case of a ton container that is used exclusively for fluorinated hydrocarbons that do not contain components that are corrosive to the tank, the requirements of clauses 9.9.2.1 and 9.9.2.2 do not apply.

9.9.3 Reporting and Records Retention

9.9.3.1 The results of the hydrostatic pressure test, air-pressure test, and visual inspection must be collected and recorded.

9.9.3.2 A report must be produced which must include:

a. Date of inspection and test;

b. Specification;

c. Ton container identification (registered symbol, serial number, date of manufacture and ownership symbol);

d. A statement pertaining to the need for refinishing or recoating the ton container;

e. Conditions checked (leakage, corrosion, gouges, dents, digs, broken or damaged chime or protective ring, fire damage, internal condition);

f. Test pressures;

g. Results of tests;

h. Disposition of ton container (returned to service, returned to manufacturer for repair, or scrapped); and

i. Identification of the facility and person conducting the retest or inspection.

9.9.3.3 The owner of a ton container must retain the reports throughout the period of ownership plus one year after the change of ownership. Upon a change of ownership, the owner must transfer the reports to the new owner. The person or facility performing the hydrostatic pressure test, air-pressure test, and visual inspection must keep the reports for at least one retest and inspection interval plus one year.

10 SELECTION AND USE OF CONTAINERS FOR THE HANDLING, OFFERING FOR TRANSPORT, OR TRANSPORTING OF DANGEROUS GOODS BY RAIL

10.1 Scope

This section applies to all containers handled, offered for transport or transported in Canada.

10.2 Selection and Use

10.2.1 General

A container must not be used in the handling, offering for transport, or transporting of dangerous goods unless clause 4.4 or Schedules 1 and 2 of Appendix E specify that the container is permitted to contain the dangerous goods and the container and dangerous goods conform to all other applicable requirements set out in this standard. In the case of a tank car, the dangerous goods must be specified on the Certificate of Construction, Form AAR 4-2, or by addendum on Form R-1.

10.2.2 Due Date for Qualification

Unless otherwise specified in this standard:

a. subject to clause 10.2.2.b, when a container is due for a qualification, the container must not be loaded; and

b. when a container becomes due for a qualification after loading, unloading or during transport, the container must not be transported to one or more destinations, except for the purposes of unloading, cleaning and qualification.

10.2.3 Prohibition of Old Ton Containers

A ton container that was manufactured before January 1, 1936, must not be used in the handling, offering for transport, or transporting of dangerous goods.

10.2.4 Localized dents and buckles

Except for localized dents or buckles in the shell that are within the limits of this clause, a tank car that has dents or buckles in its shell or heads must not be used to handle, offer for transport or transport dangerous goods. A tank car with a localized dent or buckle in its shell may be used if:

a. the localized dent or buckle in the tank shell has a depth no greater than 19.1 mm (3/4 in.) at its deepest point, when that depth is measured relative to the surrounding un-deformed external surface of the tank shell; and

b. where any portion of the localized dent or buckle is in the bottom shell, the dent or buckle has a depth no greater than 12.7 mm (1/2 in.) at its deepest point when that depth is measured relative to the surrounding un-deformed external surface of the tank shell.

10.2.5 Minimum Test Pressure

10.2.5.1 A tank car or ton container must have a tank test pressure equal to or greater than the greatest of the following:

a. 133% of the WP;
b. 133% of the maximum loading or unloading pressure, whichever is greater;
c. 2068 kPa (300 psi) for dangerous goods toxic by inhalation;
d. The minimum test pressure for the specification in section 8 of this standard; and
e. The minimum test pressure specified for the specific dangerous goods in the applicable special provision in Schedule 1 of Appendix E.

10.2.5.2 Higher Test Pressure

Unless otherwise specified in this standard, when a tank car or ton container with a given specification and tank test pressure is authorized, a tank car or ton container with the same specification and a higher marked tank test pressure may be used.

10.2.6 Air-enriched Mixture

Air pressure in excess of ambient atmospheric pressure must not be used to load or unload dangerous goods if this could create a flammable mixture within the vapour space of the container.

10.2.7 Prohibition Against Certain Stub Sill Tank Cars

A Class 111 or AAR 211 tank car of stub sill design must not be used to handle, offer for transport or transport dangerous goods if:

a. the tank car has a shell manufactured of non-normalized ASTM 515 grade 70 steel;

b. the bottom shell does not have exterior heater coils; and

c. the bottom shell has not been continuously reinforced between the end of one of the stub sill's reinforcing plate (stub sill cradle pad) to the end of the other stub sill's reinforcing plate by reinforcing steel bars, steel plate or other structural shapes or by other structural elements such as a bottom discontinuity protection device.

10.3 Safety Systems

10.3.1 Bottom-discontinuity Protection

10.3.1.1 General Requirement

Subject to clauses 10.3.1.2, 10.3.1.3 and 10.3.1.4, a tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods must be equipped with bottom-discontinuity protection that conforms to the requirements set out in paragraphs E8.0 and E9.0, of the AAR *Specifications for Tank Cars* publication.

10.3.1.2 Retrofit Requirement

For a tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods that was not required to be equipped with bottom-discontinuity protection before September 1, 1998 under the terms of Appendix Y of the AAR *Specifications for Tank Cars* publication, the tank car must conform to the bottom-discontinuity requirements set out in paragraphs E8.0 and E9.0, of the AAR *Specifications for Tank Cars* publication.

10.3.1.3 Old Protection Systems

For a tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods on which the bottom-discontinuity protection was modified before September 1, 1998, the tank car must conform to the bottom-discontinuity protection requirements set out in either Appendix Y or paragraphs E8.0 and E9.0 of the AAR *Specifications for Tank Cars* publication.

10.3.1.4 Exceptions

The requirements of clause 10.3.1 do not apply to tank cars built prior to 1979 transporting:

a. UN2448, molten sulfur;

b. UN3257, elevated temperature liquid, n.o.s.; or

c. UN3258, elevated temperature solid, n.o.s.

10.3.2 Coupler Vertical Restraint System

A tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods by rail must be equipped with a coupler vertical restraint system that conforms to the requirements set out in clause 8.2.5.

10.3.3 Pressure-relief Devices on a Tank Car

Unless otherwise specified in this standard, a tank car must be equipped with one or more pressure-relief devices that conform to the requirements set out in clause 8.2.6.

10.3.3.1 Non-reclosing Prohibition

Subject to clauses 10.3.3.2, 10.3.3.3 and special provisions of Schedule 1 in Appendix E, in the case of a tank car is or may be used in the handling, offering for transport or transporting of dangerous goods that are classified as Division 6.1 Liquid, Packing Group I or II, Class 2 Gases, or Class 3 or 4 Liquids, the tank car must not be equipped with a non-reclosing pressure-relief device.

10.3.3.2 Exception re: Tank Car Manufactured Before 1991

If the dangerous goods are classified as a Division 6.1 Liquid or Class 4 Liquid and the liquid is not toxic by inhalation, a tank car that is equipped with a non-reclosing pressure-relief device and that was manufactured before 1991 may be used in the handling, offering for transport, or transporting of the dangerous goods.

10.3.3.3 Exception re: Chloroprene

In the case of a shipment of chloroprene, inhibited, in a Specification 115 tank car, clause 10.3.3.1 does not apply.

10.3.3.4 Rupture Disc

The rupture disc of a non-reclosing pressure-relief device must not have an opening.

10.3.4 Tank-head Puncture-resistance System

A tank car that is or may be used in the handling, offering for transport, or transporting of Class 2 gases or that is manufactured from aluminum or nickel plate and is or may be used in the handling, offering for transport, or transporting of dangerous goods must have a tank-head puncture-resistance system installed that conforms to the requirements set out in clause 8.2.8 or to the corresponding requirements in effect at the time of installation.

10.3.5 Thermal Protection System

10.3.5.1 Application

Subject to clauses 9.5.10.1 and 10.3.5.2, a tank car that is or may be used in the handling, offering for transport, or transporting of Class 2 gases, other than cryogenic liquids, must have a thermal protection system that conforms to clause 8.2.7.

10.3.5.2 Exception for Some Insulated Tank Cars

Clause 10.3.5.1 does not apply in the case of a tank car for which this standard specifies that an insulation system having an overall thermal conductance equal to or less than 0.613 $kJ/h{\cdot}m^{2}{\cdot}°C$ (0.03 $Btu/h{\cdot}ft.^{2}{\cdot}°F$) is required and the tank car is equipped with the required system.

10.3.6 Safety Systems Delimiter

Unless otherwise prohibited, if this standard permits or requires the use of a tank car with a specification delimiter, a tank car of equivalent specification with an alternate delimiter in accordance with the following table may also be used:

Specified Delimiter	Delimiters Also Permitted
A	S, T, J, P
S	T, J, P
T	J, P
J	P
P	J

10.4 Loading Limits and Outage

10.4.1 Loading Limits

10.4.1.1 Application

A container must not be loaded with dangerous goods in excess of the loading limits specified in this standard or those otherwise applicable to the container.

10.4.1.2 Association of American Railroads Limit

Subject to clause 10.4.1.3, a tank car must not be loaded in excess of the total mass on rail limits per applicable axle size specified in the *Field Manual of the Association of American Railroads Interchange Rules*.

10.4.1.3 Post-1970 Manufacture

Except as otherwise provided in clauses 10.4.1.4, 10.4.1.5, 10.4.1.6, and 10.4.1.7, a tank car manufactured after November 30, 1970 must not be loaded in excess of the total mass on rail limits per applicable axle size specified in the *Field Manual of the Association of American Railroads Interchange Rules* or 119 295 kg (263 000 lb.) gross mass, whichever is less.

10.4.1.4 Increased Gross Masses

A Class DOT or TC 105, 111, 112, 113, 115, 117 or 120 tank car with a steel tank car tank manufactured in accordance with par. 2.5 of the AAR *Specifications for Tank Cars* publication, may exceed 119 295 kg (263 000 lb) gross mass, but may not exceed 129 727 kg (286 000 lb) gross mass provided that:

a. the tank capacity conforms to clause 8.2.4;

b. the tank car is equipped with one or more pressure-relief devices conforming to clause 8.2.6. Reclosing pressure-relief devices must be used unless the tank car owner can demonstrate that the use of such a device decreases the level of safety below that afforded by a non-reclosing pressure-relief device; and

c. the tank car conforms to all other applicable requirements of this standard, including qualification and maintenance.

10.4.1.5 AAR Tank Cars

A tank car with a carbon steel tank car tank permanently marked (i.e. stamped, etched, embossed or otherwise marked) to a TC 111 or DOT 111 specification and stencilled to an AAR 211 specification used in the handling, offering for transport, or transporting of dangerous goods referenced to Special Provision 2 or 67 may exceed 119 295 kg (263 000 lb.) gross mass, but may not exceed 129 727 kg (286 000 lb.) gross mass provided that:

a. the tank capacity conforms to clause 8.2.4;

b. the tank conforms to all other requirements of this standard applicable to the TC or DOT as-built specification with gross mass equal to or less than 119 295 kg (263 000 lb.), including qualification and maintenance;

c. the tank car tank is manufactured from ASTM A516, Grade 70 material, or AAR TC-128, Grade B material;

d. a non-jacketed tank car has a minimum shell and head thickness of 12.7 mm (1/2 in.) for ASTM A516, Grade 70 material, or 11.1 mm (7/16 in.) for AAR TC-128, Grade B material;

e. a jacketed tank car has a minimum shell and head thickness of 11.1 mm (7/16 in.).;

f. the tank car is equipped with one or more pressure-relief devices conforming to clause 8.2.6. Reclosing pressure-relief devices must be used unless the tank car owner can demonstrate that the use of such a device decreases the level of safety below that afforded by a non-reclosing pressure-relief device;

g. the tank car meets all the requirements of AAR S-286;

h. the tank car design meets all Road Environment Percent Occurrence Spectrum (REPOS) loading, including horizontal and vertical coupler loads, increased by a factor of 1.09 above the loading used for cars having a gross mass of 119 295 kg (263 000 lb.); and

i. the tank car is subject to a Qualification and Maintenance Program that identifies the required inspection items, inspection methods, acceptance criteria and inspection frequencies and provides written procedures that ensure the work on the tank car conforms to the applicable regulations, industry and car owner's requirements.

10.4.1.6 Equivalency Certificates

A tank car that was previously authorized to exceed 119 295 kg (263 000 lb.), but not to exceed 129 727 kg (286 000 lb.) gross mass under equivalency certificate SR 5144, SR 5206, SR 6753, SR 7677, SR 7790, SR 8841, or SR 9292, may continue in service provided that:

a. the tank car conforms to all the conditions specified in the most current revision of the applicable equivalency certificate and all other requirements of this standard applicable to tank cars with gross mass equal to or less than 119 295 kg (263 000 lb.), including qualification and maintenance; and

b. the tank car is equipped with a pressure-relief device conforming to clause 8.2.6 and the pressure-relief device is installed as described in the document submitted to support the equivalency certificate application and on file with the Director.

If a tank car authorized for transport under an equivalency certificate is determined to meet all the requirements of the standard, the equivalency certificate stencil must be removed at the next tank qualification.

10.4.2 Outage

10.4.2.1 Vacant Space for Outage

Vacant space must be left in the shell of the tank to provide the required outage.

10.4.2.2 Filling Limit

When a container is being filled with liquids, outage must be provided so that, under normal conditions of transport, including handling, no condition or release of dangerous goods that could endanger public safety occurs or may reasonably be expected to occur, including leakage or permanent distortion of the container, as a result of an expansion of the liquid.

10.4.2.3 Minimum Outage

Unless otherwise specified in this standard, for liquids and liquefied gases that are loaded into a container, the minimum outage must be:

a. equal to or greater than 1% of the total capacity of a tank or a compartment of the tank at one of the following reference temperatures:

   i. 46.1 °C (115 °F) for a non-insulated tank;

ii. 43.3 °C (110 °F) for insulated tanks or tanks having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance equal to or less than 10.2 kJ/h·m^{2}·°C (0.50 Btu/h·ft.^{2}·°F); or

iii. 40.6 °C (105 °F) for an insulated tank when the overall thermal conductance is equal to or less than 1.533 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F).

b. for dangerous goods toxic by inhalation, the outage must be equal to or greater than 5% of the total capacity of the tank or a compartment of the tank, at one of the following reference temperatures:

i. 46.1 °C (115 °F) for a non-insulated tank;

ii. 43.3 °C (110 °F) for insulated tanks or tanks having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance equal to or less than 10.2 kJ/h·m^{2}·°C (0.50 Btu/h·ft.^{2}·°F); or

iii. 40.6 °C (105 °F) for an insulated tank when the overall thermal conductance is equal to or less than 1.533 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F).

10.5 Specific Dangerous Goods

10.5.1 Dangerous Goods Toxic by Inhalation

10.5.1.1 General Requirements

a. A tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods toxic by inhalation must not have interior heater coils or bottom outlets.

b. Unless otherwise specified in this standard, a tank car that is or may be used in the handling, offering for transport, or transporting of dangerous goods toxic by inhalation must have a tank test pressure of 2068 kPa (300 psi) or greater, a tank-head puncture-resistance system, and a metal jacket (e.g. 105S300W).

10.5.1.2 Tank Cars and Ton Containers for Dangerous Goods Toxic by Inhalation Other Than Class 2 Gases

a. the following conditions apply to tank cars built before January 15, 2015 and ton containers of any built date that are or may be used in the handling, offering for transport or transport of dangerous goods toxic by inhalation, other than Class 2, Gases:

i. dangerous goods that meet the criteria for Hazard Zone A must be handled, offered for transport or transported in tank cars or ton containers having a test pressure equal to or greater than 3447 kPa (500 psi) and conform to classes 105J, 106 or 110;

ii. dangerous goods that meet the criteria for Hazard Zone B must be handled, offered for transport or transported in tank cars or ton containers having a test pressure equal to or greater than 2068 kPa (300 psi) and conform to classes 105S, 106, 110, 112J, 114J or 120S;

iii. hydrogen fluoride, anhydrous must be handled, offered for transport or transported in tank cars or ton containers having a test pressure equal to or greater than 2068 kPa (300 psi) and conform to classes 105, 106, 110, 112, 114 or 120; and

iv. tank cars must have been approved by the Executive Director for the specific dangerous goods or alterations and conversions documented for change of service to the specific dangerous goods on the Certificate of Construction, Form AAR 4-2, or by addendum on Form R-1.

b. Subject to paragraph c., tank cars built after January 15, 2015 and that are or may be used in the handling, offering for transport, or transporting of dangerous goods toxic by inhalation, other than Class 2, Gases, set out in column 1 of the following table must conform to the applicable tank car specification set out in column 2 and, when applicable, clauses 10.5.1.2.b. i. and ii.

Dangerous Goods	Authorized Tank Car Specification
Acetone cyanohydrin, stabilized	105J500W 112J500W
Acrolein	105J600W
Allyl alcohol	105J500W 112J500W
Bromine or bromine solutions	105J500W
Chloropicrin	105J500W 112J500W
Chlorosulphonic acid	105J500W 112J500W
Dangerous goods toxic by inhalation, hazard zone A, not specifically identified in this table	105J600W
Dangerous goods toxic by inhalation, hazard zone B, not specifically identified in this table	105J500W 112J500W
Dimethyl sulphate	105J500W 112J500W
Ethyl chloroformate	105J500W 112J500W
Hexachlorocyclopentadiene	105J500W 112J500W

Dangerous Goods	**Authorized Tank Car Specification**
Hydrocyanic acid, aqueous solution or Hydrogen cyanide, aqueous solution, with not more than 20% hydrogen cyanide	105J500W 112J500W
Hydrogen cyanide, stabilized	105J600W
Hydrogen fluoride, anhydrous	105J500W 112J500W
Phosphorus trichloride	105J500W 112J500W
Sulphur trioxide, stabilized	105J500W 112J500W
Sulphuric acid, fuming (where the free sulphur trioxide content is greater than or equal to 30%)	105J500W 112J500W
Titanium tetrachloride	105J500W 112J500W

i. Each tank car used for Acetone cyanohydrin, stabilized or Acrolein must have a reclosing pressure relief device having a start-to-discharge pressure of 1034 kPa (150 psi).

ii. Each tank car used for Hydrogen cyanide, stabilized or Hydrogen cyanide, aqueous solution, with not more than 20% hydrogen cyanide must have a reclosing pressure relief device having a start-to-discharge pressure of 1551 kPa (225 psi).

c. As an alternative to the authorized tank car specifications listed in the table in clause 10.5.1.2.b, a tank car of the same specification but of the next lower test pressure, as prescribed in the table in clause 8.3.22, may be used provided that both of the following conditions are met:

i. The difference between the alternative and the required minimum plate thicknesses, based on the calculation using the formula in clause 8.3.6.1, must be added to the alternative tank car jacket and head shield. When the jacket and head shield are made from steel with a minimum tensile strength from 483 to 558 MPa (70 000 psi to 81 000 psi), but the required minimum plate thickness calculation is based on steel with a minimum tensile strength of 558 MPa (81 000 psi), the thickness to be added to the jacket and head shield must be increased by a factor of 1.157. Forming allowances for heads are not required to be considered when calculating thickness differences; and

ii. The tank car jacket and head shields are manufactured from carbon steel plates as prescribed in clause 8.3.5.1. The steel must meet the Charpy requirements of par. 2.2.1.2 of the AAR *Specifications for Tank Cars* publication and head shields must be normalized after forming.

d. A higher test pressure is required if otherwise specified elsewhere in this standard.

10.5.1.3 Tank Cars for Dangerous Goods Toxic by Inhalation

a. Tank cars built prior to January 15, 2015 that are or may be used in the handling, offering for transport or transport of dangerous goods toxic by inhalation must have been approved by the Executive Director for the specific dangerous goods or alterations and conversions documented for change of service to the specific dangerous goods on the Certificate of Construction, Form AAR 4-2, or by addendum on Form R-1.

b. Each tank car manufactured after January 15, 2015 and that is or may be used in the handling, offering for transport, or transporting dangerous goods toxic by inhalation must meet the applicable authorized tank car specification and standard listed in clauses 10.5.1.2 b. and 10.5.1.2 c. and Special Provisions 62, 64, 65, 80, 81, 82, or 83 of Schedule 1 of Appendix E.

c. (RESERVED)

d. A tank car owner retiring or otherwise removing a tank car from service transporting dangerous goods toxic by inhalation, other than because of damage to the tank car, must retire or remove a tank car manufactured of non-normalized steel in the head or shell before removing any tank car in service transporting dangerous goods toxic by inhalation manufactured of normalized steel meeting the applicable tank car specification.

e. The transportation of dangerous goods toxic by inhalation in tank cars manufactured using non-normalized steel in the head or shell shall be prohibited two years after the coming into force of this standard.

10.5.1.4 Service Equipment Protection

A tank car manufactured after January 15, 2015 that is or may be used in the handling, offering for transport or transport of dangerous goods toxic by inhalation must have a protective housing that complies with clause 8.2.3.5.

10.5.1.5 Performance Requirement for Alternative Tank Car

An application for approval by the Executive Director of a tank car manufactured in accordance with the alternatives authorized in clause 10.5.1.2 c. or Special Provision 83 of Schedule 1 of Appendix E must include a demonstration through engineering analysis, that the tank jacket and support structure system, including any anchors and support devices, is capable of withstanding a 9.6 km/h (6 miles per hour) coupling without jacket shift such that results in damage to the nozzle.

10.5.2 Assignment of Hazard Zones for Dangerous Goods Toxic by Inhalation

10.5.2.1 Division 2.3

For the purposes of this standard, the hazard zone of Class 2, Division 2.3 dangerous goods is assigned in Schedule 2 of Appendix E.

10.5.2.2 Liquid Dangerous Goods other than Class 2 gases

For the purposes of this standard, the hazard zone of liquid dangerous goods other than Class 2 gases is assigned in Schedule 2 of Appendix E.

10.5.2.3 Determination

a. If Schedule 2 in Appendix E does not provide a hazard zone or provides more than one hazard zone for Class 2, Division 2.3 dangerous goods, or indicates that the hazard zone must be determined on the basis of the grouping criteria for Division 2.3, the hazard zone must be determined by applying the following criteria:

Hazard Zone	Inhalation Toxicity
A	LC_{50} less than or equal to 200 ppm
B	LC_{50} greater than 200 ppm and less than or equal to 1000 ppm
C	LC_{50} greater than 1000 ppm and less than or equal to 3000 ppm
D	LC_{50} greater than 3000 ppm or less than or equal to 5000 ppm

b. If Schedule 2 in Appendix E does not provide a hazard zone or provides more than one hazard zone for liquid dangerous goods other than Class 2 gases, or indicates that the hazard zone must be determined, the hazard zone must be determined by applying the following criteria:

   i. Hazard Zone A: $V \geq 500\ LC_{50}$ and $LC_{50} \leq 200\ mL/m^3$

   ii. Hazard Zone B: $V \geq 10\ LC_{50}$; $LC_{50} \leq 1000\ mL/m^3$; and the criteria for Hazard Zone A are not met.

   Where V is the saturated vapor concentration in air of the material in mL/m^3 at 20 °C and at 101.3 kPa.

10.5.3 Dangerous Goods in Packing Groups I or II

10.5.3.1 A class 111 tank car built after October 1, 2015 and used in the handling, offering for transport, or transporting of dangerous goods in packing groups I or II, other than dangerous goods toxic by inhalation and Class 3, Flammable Liquids, must conform with the requirements for an enhanced class 111 with a jacket or an enhanced class 111 without a jacket (clause 8.3.24).

10.5.4 Cryogenic Liquids

The interior of the inner tank of a cryogenic liquid tank car and all connecting lines must be thoroughly cleaned, dried, and protected from further contamination before use.

10.5.5 (RESERVED)

10.5.6 Dangerous Goods in Class 3, Flammable Liquids

Subject to clause 10.5.6.1, a tank car that is or may be used to import, offer for transport, handle or transport dangerous goods included in Class 3, Flammable Liquids that are assigned Special Provision 86 in Appendix E, must be in compliance with specification 117J, 117P, 105J, 112J, 114J or 120J. If the tank car is specification 114J or 120J and is equipped with a bottom outlet valve, the tank car must be compliant with clause 8.3.10.9.

10.5.6.1 Tank Cars Manufactured Prior to October 1, 2015

10.5.6.1.1 A tank car that was manufactured prior to October 1, 2015, may be used to import, offer for transport, handle or transport dangerous goods that are

i. UN1267, PETROLEUM CRUDE OIL,
ii. UN1268, PETROLEUM DISTILLATES, N.O.S., or PETROLEUM PRODUCTS, N.O.S., that is crude oil, or
iii. UN3494, PETROLEUM SOUR CRUDE OIL, FLAMMABLE, TOXIC

if the tank car is in compliance with:

a. specification 117R;
b. the specification for an enhanced class 111 tank car with a jacket and is used no later than April 30, 2025;
c. the specification for an enhanced class 111 tank car without a jacket and is used no later than March 31, 2020; or
d. class 111, not in compliance with paragraphs b. or c., and is used no later than October 31, 2016.

10.5.6.1.2 A tank car that was manufactured prior to October 1, 2015, may be used to import, offer for transport, handle or transport dangerous goods that are

i. UN1170, ETHANOL more than 24% ethanol, by volume;
ii. UN1987, ALCOHOLS, N.O.S.;
iii. UN1993, FLAMMABLE LIQUID, N.O.S., that is ethanol, solutions comprised mostly of ethanol, denatured ethanol or ethanol and gasoline mixtures; or
iv. UN3475, ETHANOL AND GASOLINE MIXTURE with more than 10% ethanol, ETHANOL AND MOTOR SPIRIT MIXTURE with more than 10% ethanol, or ETHANOL AND PETROL MIXTURE with more than 10% ethanol

if the tank car is in compliance with:

a. specification 117R;
b. the specification for enhanced class 111 tank car with a jacket and is used no later than April 30, 2025;
c. the specification for an enhanced class 111 tank car without a jacket and is used no later than June 30, 2023; or
d. class 111, not in compliance with paragraphs b. or c., and is used no later than April 30, 2023.

10.5.6.1.3 A tank car that was manufactured prior to October 1, 2015, may be used to import, offer for transport, handle or transport dangerous goods that are assigned Special Provision 86 in Appendix E, other than the dangerous goods listed in clause 10.5.6.1.1 and clause 10.5.6.1.2, if the tank car is in compliance with:

a. specification 117R; or
b. class 111 and is used no later than April 30, 2025.

10.5.7 Combustible Liquids

Despite Clause 10.5.6, combustible liquids (i.e., liquids that are not dangerous goods but have a flash point greater than 60 °C and less than or equal to 93 °C and are transported at a temperature below their flashpoint) may be imported, handled, offered for transport or transported in any tank car meeting this standard, including specification TC/DOT 111 and AAR 211.

10.6 Loading and Unloading Railway Vehicles

10.6.1 Prohibition Against Movement

During the period of time when dangerous goods are being loaded into or onto a railway vehicle or unloaded from a railway vehicle, that railway vehicle and any railway vehicle to which it is attached must not be moved.

10.6.2 General Loading / Unloading Conditions

Dangerous goods must not be loaded into or onto a railway vehicle or unloaded from a railway vehicle unless the following requirements are met. Except for paragraphs b, c and d, the following requirements do not apply to a railway vehicle that is a boxcar, flatcar or hopper car:

a. Dangerous goods with a primary or subsidiary classification of Class 3, 4, 5 or Division 2.1 must take fire safety measures to prevent the ignition of the dangerous goods, including grounding and bonding the tank cars, before any loading or unloading related activities have begun and must remain until all loading or unloading activities have concluded.

b. Ensure that the railway vehicle or coupled string of railway vehicles are immobilized by using hand brakes and by blocking the wheels. As a minimum, the hand brakes must be applied and at least one wheel must be blocked in both directions on at least:

   i. one car for a one or two car coupled string; or

   ii. two cars for a three to nine car coupled string plus one additional car for every block and any fraction of block of ten cars in excess of the first nine cars in the coupled string, including the first and last cars of the string;

c. Ensure that the section of track is protected by locked switches, locked derails, bumper blocks or other such equipment controlled by the loading or unloading facility.

d. Caution signs are displayed to warn approaching railway vehicle operators. Caution signs must be manufactured of metal or other durable metal having dimensions equal to or greater than 300 mm x 380 mm (12 in x 15 in) and bear the words

"STOP" or "ARRÊT" in white capital letters equal to or greater than 100 mm (4 in) in height on a blue background.

e. The immediate vicinity of the railway vehicle is kept free of combustible materials or other dangerous goods not compatible with the commodity being loaded or unloaded.

f. In the case of a tank car, precautions are taken to prevent the release of dangerous goods while the tank car is being loaded or unloaded. When the loading or unloading is completed, all closures are secured and the connections made between the tank car service equipment and the loading or unloading components are disconnected.

g. If loading or unloading is discontinued, the loading or unloading connections may remain attached provided that the shutoff valves and the facility's first fixed isolation valve, when so equipped, are closed and secured in the closed position and all other conditions of clause 10.6.2 are met, including 10.6.2.h.

h. The loading / unloading operations are directly, remotely or automatically monitored to ensure safety and prompt response in the event of an emergency.

i. If applicable, measures are taken to minimize the release of dangerous goods when interconnecting pipes are used.

j. Measures are taken to control the pressure inside the tank car during loading and unloading operations, including avoiding an excessive vacuum condition.

k. Hoses, and their connectors, used to temporarily connect to the railway vehicle to load or unload dangerous goods must be visually inspected prior to each use. Loading and unloading hoses and their connectors must be tested periodically in accordance with the manufacturer's recommendations. A test report must be generated and kept until the next report is produced.

l. When it is safe to do so, the interior pressure is relieved before the removal of the manhole cover or valve outlet cap.

10.7 Loading of Containers

10.7.1 Before Loading

A container must not be loaded with dangerous goods if:

a. The container does not conform to the requirements for selection and use set out in this standard.

b. The required dangerous goods safety marks are not in place.

c. The container is past due for qualification.

d. The container is manufactured from a material, or has a lining or coating, that is not compatible with the dangerous goods being loaded.

e. The container already contains dangerous goods or other substances that could react with the dangerous goods to be loaded.

f. The dangerous goods are at a temperature outside the design temperature range of the container or outside the service temperature range of the lining or coating.

g. Before loading through a bottom outlet valve, ensure that:
   i. The valves, hoses, pipes and couplers are properly designed and rated for loading the lading;
   ii. Mechanisms are in place to safely deal with hazards such as overloads, overpressures, leaks and fires; and
   iii. Mechanisms are in place to safely evacuate the lading from the valves, hoses, pipes and couplers to avoid causing a dangerous goods release.

10.7.2 During Loading

During the period of time that a tank car is being loaded, tank cars equipped with bottom discharge outlets require that the caps and plugs of the outlets and secondary valves be removed.

10.8 After Loading

After loading a dangerous goods container, a person must conduct an external visual inspection that includes:

a. Except where insulation or a thermal protection system precludes an inspection, an examination of the tank shell and heads for abrasion, corrosion, cracks, dents, distortions, defects in welds, damage or any other condition that makes the tank car unsafe for transportation.

b. Inspecting the piping, valves, fittings and gaskets for corrosion, damage, or any other condition that makes the tank car unsafe for transportation.

c. Ensuring that there are no missing or loose bolts, nuts or elements that make the tank car unsafe for transportation.

d. Ensuring that all closures of openings, as well as the fasteners securing them on the container, are in good condition and secured to achieve conformance with clause 4.10.2.

e. Except on tank cars used in the handling, offering for transport, or transporting of Class 2 gases or tank cars being returned after unloading, inspecting pressure-relief devices, including the removal and inspection of rupture discs on safety vents, for any condition that could alter the intended operation of the device or endanger public safety, including corrosion or damage.

   The rupture disc is not required to be removed prior to visual inspection if the tank car contains only residual quantities of a Class 8, packing group II or III material with no subsidiary hazard or Class 9 elevated temperature material.

f. For a combination pressure-relief device incorporating a rupture disc, inspecting and opening each detection device including a needle valve, trycock or telltale indicator to ensure the integrity of the rupture disc.

g. Inspecting the thermal protection system, tank-head puncture-resistance system, coupler vertical restraint system, and bottom discontinuity protection for any condition that make the tank car unsafe for transportation.

h. Inspecting for spillage of dangerous goods on the exterior surface of the container and ensuring that it is removed, except for dried molten sulphur residue as described in the Sulphur Institute's "Molten Sulphur Rail Tank Car Guidance" document.

i. Inspecting the compliance markings for legibility and correctness.

j. Inspecting the external surface of ceramic type filters on tank cars equipped with a venting device and transporting hydrogen peroxide, aqueous solution with more than 40% hydrogen peroxide, stabilized, except on tank cars being returned after unloading.

k. Inspecting the periodic inspection date markings to ensure that they are within the prescribed intervals.

10.9 Before Transporting

Before transporting a container containing dangerous goods, the person who will be transporting the container must conduct an external visual inspection of the container, to the extent practicable, from the ground level to ensure that:

a. The required dangerous goods safety marks are in place and in conformance with the TDG Regulations.

b. Closures of openings are in good condition and properly secured.

10.10 Rail Operating Restrictions

10.10.1 Highway Tanks

Highway tanks may be transported on railway vehicles if the rail destination is in a remote area not accessible by road, and provided that all applicable conditions are complied with:

a. the dangerous goods are in Class 3, 8 or 9;

b. the tank and any compartment of the tank contain a volume of liquid dangerous goods that is equal to or less than 5% of the tank or compartment's volumetric capacity respectively;

c. the highway tank is selected and used in accordance with the requirements of the standard CSA B621, except that the use of non-specification highway tanks is not authorized;

d. in the case of a tank truck, the tank truck is secured to the railway vehicle in accordance with the requirements of AAR *Open Top Loading Rules Manual for Four or six wheel truck or other motor vehicle*;

e. in the case of a tank trailer, the forward end of the trailer is secured to the railway vehicle with an AAR approved intermodal trailer hitch, the rail carrier personnel has verified that the king pin of the trailer is engaged and locked in the trailer hitch, the rear end is secured in accordance with the requirements of the AAR *Open Top Loading Rules Manual for Trailers*, all types and the landing gear and bumper are not used for securing the trailer to the railway vehicle;

f. in the case of a tank trailer transported with its tractor, the tractor is transported on a separate railway vehicle;

g. before the person responsible for the road transport of the dangerous goods releases the highway tank to the rail carrier, that person inspects the attachment points of the tank to the truck or trailer frame to detect any condition that may compromise the integrity of the securement of the tank to the frame, ensure that the highway tank has all valves and closures, at the exclusion of the pressure-relief device, securely closed and capped as applicable, and reports the results of this inspection and this verification to the rail carrier; and

h. unless it is likely to have a serious impact on train dynamics, the railway vehicle on which the highway tank is transported is separated by at least one railway vehicle from a railway vehicle for which a placard is required to be displayed in accordance with Part 4 of the TDG Regulations, is separated by at least one railway vehicles from the locomotive and is located at the tail end or as close as possible to the tail end of the train and behind any loaded railway vehicle.

10.10.2 Transportation of Dangerous Goods in or on Hi-rail Equipment

Tank trucks transporting Class 2 gases or Class 3 flammable liquids must comply with the requirements of CSA B621 or CSA B622, be properly secured, filled, and closed so that during the course of normal transportation, there will be no release of dangerous goods that could endanger public safety; and:

a. the hi-rail vehicle equipment is authorized by the operating railway, and is not physically connected to any other railway vehicle; and

b. the hi-rail vehicle must be in the control of a railway employee qualified under the Canadian Rail Operating Rules.

10.10.3 Handling of Tank Cars Conforming to Specification 113 and AAR 204W

A tank car conforming to Specification 113 and AAR 204W must not be:

a. uncoupled while in motion;

b. coupled into with more force than is necessary to complete the coupling; or

c. struck by any railway vehicle moving under its own motion.

11 PROVISIONS FOR THE ONE TIME MOVEMENT OF NON-CONFORMING CONTAINERS PRESENTING LOW SAFETY RISKS

11.1 Scope

The purpose of this section is to authorize the one time movement within Canada of certain non-conforming containers where the non-conformance is relatively minor in nature or where measures have been taken to reduce the safety risks to a minimal level. In all cases, the movement must be for the purposes of cleaning, testing, repairing, dismantling or unloading containers that are not actively leaking and only when it is not possible or unsafe to remedy the non-conformance at the location where it was discovered. Railway vehicles must be in conformance with the standard prior to the discovery of a non-conformity requiring the use of the clauses in Section 11 of the standard.

11.2 Written Notifications

Written notifications are required for the one-time movement of overloaded railway vehicles by weight. Applicants may apply for written notification if:

a. a tank car is found to be overloaded by weight in transport by 1361 kg (3000 lbs) or less when measured on a weight-in-motion scale or 454 kg (1000 lbs) or less when measured on a static scale as long as the outage is within regulatory limits; or
b. a railway vehicle other than a tank car carrying solid dangerous goods is found to be overloaded by weight in transport by 2268 kg (5000 lbs) or less when measured by a scale.

Applicants must submit the following information to Transport Canada to obtain Written Notifications:

a. Scale tickets
b. Loading temperature and specific gravity of commodity at the loading temperature
c. Specific gravity of commodity at appropriate reference temperature
d. Capacity and tare weight of the container
e. Innage / outage table for the tank car
f. Any additional information that can be used to demonstrate that the tank car is not overloaded by volume.

Application details must be submitted to MOCregister-Registrecontenant@tc.gc.ca.

11.3 Low Safety Risk Approvals

11.3.1 Maintenance of Defective Tank Car Service Equipment in Transportation

11.3.1.1 Maintenance to Stop a Leak

If maintenance or temporary repair of service equipment is performed during transport to stop a leak and a leak test is required, the tank car may continue to destination without a leak test. Instances where the leak test is required would include restoration of the joint integrity between the tank car tank and service equipment, repairs or other similar maintenance such as rebuilding of service equipment. The person having conducted the maintenance or temporary repair must:

a. tag, label, or mark the service equipment in such a way as to convey the need for a leak test before the tank car is offered for transportation in the loaded condition; and

b. notify the owner of the tank car of the need for a leak test before the tank car is offered for transportation in the loaded condition.

11.3.1.2 Leak Test Required

A tank car that is identified as being in need of a leak test in accordance with the requirements set out in clause 11.3.1.1 must not be offered for transportation in the loaded condition before acceptable results from the leak test have been obtained.

11.3.1.3 Maintenance Validation

When the maintenance or temporary repair referred to in clause 11.3.1.1 is not performed by a tank car facility, or is not in accordance with the owner's procedures, the maintenance or temporary repair must be validated, and the service equipment must be leak tested by a tank car facility before the tank car is next loaded.

11.3.2 Movement of Certain Non-conforming Tank Cars and Other Railway Vehicles in Canada

Non-conforming tank cars and hopper cars in one of the situations described below may be transported for the purposes of cleaning, repairing, testing, dismantling or unloading, and only when it is not possible or unsafe to remedy the situation at the location where it was discovered.

11.3.2.1 Non-Dangerous Goods, Residue Hopper Cars and Clean Tank Cars

Subject to clause 11.3.3, a non-dangerous goods railway vehicle, a clean or residue hopper car, or a clean tank car with a non-conformity other than structural damage that could affect its product retention capability or capability to withstand normal train loads.

11.3.2.2 Tank Car with Missing or Damaged Service Equipment Parts

A tank car with missing or damaged parts of service equipment may be transported provided the integrity of the service equipment closure(s) or its capability to prevent a release is not affected. For example, missing magnetic gauging device rod, valve handle or pipe plug chain.

11.3.2.3 Tank Car with a Defective Closure with other than Class 2 Dangerous Goods.

Subject to clause 11.3.3, a tank car containing a residue of dangerous goods other than Class 2, that is empty of liquid, with a defective primary or secondary closure, but the functional primary or secondary closure is closed and properly secured and would prevent a release in transportation in accordance with clause 4.10 and the service equipment has been tagged, labelled or marked in such a way as to convey the need for repair and for a leak test before the tank car is offered for transportation in the loaded condition.

11.3.2.4 Tank car with a Defective Closure with a Residue of Class 2 Dangerous Goods.

Subject to clause 11.3.3, a tank car that has a defective closure that resulted or could have resulted in a release and that has been depressurized to 6.9 kPa (1 psi) or less, from which all liquid dangerous goods has been removed, and that would not develop any detectable release if the pressure rose slightly as a result of ambient temperature variation during transport and corrective action or maintenance has been performed. In addition, any other closure associated with the defective closure is closed and properly secured in accordance with clause 4.10.

11.3.2.5 Tank Car with Damage to a Required Jacket

Subject to clause 11.3.3, a tank car that has incurred damage solely to its jacket such that the jacket is deformed or no longer "weather tight" and the tank car retains its minimum insulation or thermal protection properties.

11.3.2.6 Tank Car with Damage to a Non-Mandatory Insulation System

Subject to clause 11.3.3, a tank car with jacket or insulation damage where insulation is not a specification requirement and the outage is no less than that authorized for a non-insulated tank car.

11.3.2.7 Tank Car with a Defective Lining or Coating

Subject to clause 11.3.3, a tank car, containing a residue of dangerous goods, with a defective internal lining or coating that has not resulted in damage to the tank shell or head.

11.3.2.8 Tank car with Defective Exterior Heater Coils

Subject to clause 11.3.3, a tank car with a defective exterior heater coil provided the defect does not compromise the integrity of the tank.

11.3.2.9 Tank Car with Defective Interior Heater Coils

Subject to clause 11.3.3, a tank car with defective interior heater coils and containing a dangerous goods residue. In addition, all end caps are placed on the coils when so equipped.

11.3.2.10 Structurally Damaged Tank Car

Subject to clause 11.3.3, a residue tank car with structural damage that does not affect its product retention capability, which is loaded on another railway vehicle and properly secured with all necessary blocks, chains and binders in accordance with applicable AAR loading and securement practices.

11.3.2.11 Tank car with a Damaged Stub Sill

Subject to clause 11.3.3, a tank car with a damaged stub sill at one end where the damage does not or is not likely to affect the tank car tank when the tank car is placed at the end of a train with the damaged end trailing.

11.3.2.12 Tank Car with Non-Critically Cracked Attachment Welds

Subject to clause 11.3.3, a tank car with a transverse or longitudinal crack in a weld attaching pads to tank or sills to pads or head braces to pads or sills. In most instances a single transverse crack equal to or less than 76 mm (3 in.) in length or a single longitudinal crack equal to or less than 152 mm (6 in.) in length will not be considered critical. If it cannot be determined with certainty that a crack resides in the weld only then the above criteria do not apply.

11.3.2.13 Tank car with Inadequate Safety Marks

Subject to clause 11.3.3, a tank car with incorrect stencilled or stamped specification marks, qualification marks or marks required by an equivalency certificate.

11.3.2.14 Damaged or Defective Protective Housing

Subject to clause 11.3.3, a Class 111, 117 or AAR211 tank car with a damaged or defective protective housing or manway cover assembly and that is leaktight.

11.3.2.15 Tank car with Defective Closure with Elevated Temperature Dangerous Goods

Subject to clause 11.3.3, a tank car with a defective primary or secondary closure and containing only elevated temperature dangerous goods that have adequately solidified to preclude any release. In addition, any other closure associated with the defective closure is closed and properly secured in accordance with clause 4.10.

11.3.3 Additional requirements

11.3.3.1 Stencilling

The tank car must be stencilled on each side adjacent to the car number in 76.2 mm (3 in.) minimum size letters with the words "DEFECTIVE CAR MOVING FOR REPAIR – DO NOT LOAD" or "WAGON DÉFECTUEUX DÉPLACÉ À DES FINS DE RÉPARATION – NE PAS CHARGER" or words/markings conveying a similar message. In addition, for tank cars with defective service equipment, the specific component must be tagged with the above wording or wording conveying a similar message.

11.3.3.2 Shipping Documents

The shipping document that accompanies the dangerous goods must indicate that the railway vehicle is moving under the authority of this section and indicate the nature of the defect.

11.3.4 Incomplete Tank Cars

Incomplete tank cars are partially manufactured tank cars meeting minimum design requirements for safe movement but are not completely manufactured for the transportation of dangerous goods.

11.3.4.1 Final Specification Stenciling for Incomplete Tank Cars

Manufactured tank cars meeting minimum safety requirements for movement may be stenciled with the final specification of the tank car despite not being completely manufactured for the transport of dangerous goods.

11.3.4.2 Stenciling

The tank car must be stenciled on each side adjacent to the car number in 76.2 mm (3 in.) minimum size letters with the words "CAR MOVING FOR MANUFACTURE – DO NOT LOAD" or "WAGON DÉPLACÉ À DES FINS DE FABRICATION – NE PAS CHARGER" or words/markings conveying a similar message.

11.3.4.3 Manufacturing Completion Deadline

The tank car must be completely manufactured for dangerous goods transport in accordance with the final specification stencil within 6 months after the stencils have been initially applied to the tank car.

11.4 Movement of Certain Non-Conforming Ton Containers

11.4.1 Service Equipment Defects

A ton container that has a leaking or defective service equipment device, other than a reclosing pressure-relief device, may be transported for the purposes of cleaning, repairing, or unloading, and only when it is not possible or unsafe to remedy the situation at the location where it was discovered, under the following conditions:

a. a Chlorine Institute Capping "Kit B" is applied to prevent any leaks;

b. the ton container is tagged to indicate it is defective;

c. the ton container with the capping kit is tested prior to transport to ensure there is no leak; and

d. the ton container is loaded and properly secured to prevent any movement during transport.

APPENDIX A – SIDE IMPACT TEST FOR TC 117P

The TC 117P side impact test is carried out as follows:

a. the tank car is restrained in the direction of impact;

b. the tank is filled, with no more than 4% outage and with no internal pressure, with lading of the same density as the dangerous goods that the tank car is intended to carry;

c. the tank may be filled with water if the dangerous goods that the tank car is intended to carry have a specific gravity of 1.1 or less;

d. the tank car is hit by a proxy object;

e. the proxy object has a mass equal to or greater than 129 727 kg (286 000 lb) and is fitted with a rigid punch that

    i. protrudes at least 1524 mm (60 in.) from the base of the proxy object, and

    ii. has a cross-section 305 mm (12 in.) high by 305 mm (12 in.) wide, with a 25.4 mm (1 in.) radius on each edge of the impact face;

    The proxy object is intended to approximate a loaded freight car, including the coupler with the knuckle removed.

f. at the instant of impact,

    i. the centre of the impact face of the punch is aligned with the intersection of the vertical and longitudinal centrelines of the tank, and

    ii. the horizontal centreline of the punch is perpendicular to the point of impact; and

g. at the instant of impact, the speed of the punch face is equal to or greater than 19.3 km/h (12 mph).

APPENDIX B – HEAD IMPACT TEST FOR TC 117P

The TC 117P head impact test is carried out as follows:

a. the tank car is restrained in the direction of impact;

b. the tank is filled, with no more than 4 per cent outage and with no internal pressure, with lading of the same density as the dangerous goods that the tank car is intended to carry;

c. the tank may be filled with water if the dangerous goods that the tank car is intended to carry have a specific gravity of 1.1 or less;

d. the tank car is hit by a proxy object;

e. the proxy object has a mass equal to or greater than 129 727 kg (286 000 lbs) and is fitted with a rigid punch that:

   i. protrudes at least 1524 mm (60 in.) from the base of the proxy object, and

   ii. has a cross-section 305 mm (12 in.) high by 305 mm (12 in.) wide, with a 25.4 mm (1 in.) radius on each edge of the impact face;

   The proxy object is intended to approximate a loaded freight car, including the coupler with the knuckle removed.

f. at the instant of impact,

   i. the centre of the impact face of the punch is aligned with the centre of the tank head, and

   ii. the horizontal centreline of the punch is perpendicular to the point of impact; and

g. at the instant of impact, the speed of the punch face is equal to or greater than 29 km/h (18 mph).

APPENDIX C – PROCEDURES FOR TANK-HEAD PUNCTURE-RESISTANCE TESTING

C1. TANK-HEAD PUNCTURE-RESISTANCE SYSTEMS

C1.1 This test procedure is designed to verify the integrity of new or untried tank-head puncture-resistance systems and to test for system survivability after coupler-to-tank head impacts at relative speeds of 29 km/h (18 mph). Tank-head puncture-resistance is a function of one or more of the following: head thickness, jacket thickness, insulation thickness, and material of manufacture.

a. Tank-head Puncture-resistance Test — A tank-head puncture-resistance system must be tested under the following conditions:

   i. The ram car used must be at least 119 295 kg (263 000 lb), must be equipped with a coupler, and must duplicate the condition of a conventional draft sill including the draft yoke and draft gear. The coupler must protrude from the end of the ram car so that it is the leading location of perpendicular contact with the impacted test car;

   ii. The impacted test car must be loaded with water at 6% outage with internal pressure of at least 689 kPa (100 psi) and coupled to one or more backup cars which have a total mass of 217 724 kg (480 000 lb) with hand brakes applied on the last backup car; and

   iii. At least two separate tests must be conducted with the coupler on the vertical centreline of the ram car. One test must be conducted with the coupler at a height of 533 ± 25 mm (21 ± 1 in.), above the top of the sill; the other test must be conducted with the coupler height at 790 ± 25 mm (31 ± 1 in.), above the top of the sill. If the combined thickness of the tank head and any additional shielding material is less than the combined thickness on the vertical centreline of the car, a third test must be conducted with the coupler positioned so as to strike the thinnest point of the tank head.

b. One of the following test conditions must be applied:

Mass of Attached Ram Cars, Minimum kg (lb)	Velocity of Impact, Minimum km/h (mph)	Restrictions
119 295 (263 000)	29 (18)	One ram car only
155 582 (343 000)	25.7 (16)	One ram car or one car plus one rigidly attached car
311 164 (686 000)	22.5 (14)	One ram car plus one or more rigidly attached cars

c. A test is successful if there is no visible leak from the standing tank car for a minimum of one hour after impact.

APPENDIX D – PROCEDURES FOR SIMULATED POOL-FIRE AND TORCH-FIRE TESTING

D1. THERMAL PROTECTION SYSTEMS

D1.1 This test procedure is designed to measure the thermal effects of new or untried thermal protection systems and to test for system survivability when exposed to a 100 minute pool fire and a 30 minute torch fire.

D1.1.1. Simulated Pool-fire Test

a. A pool-fire environment must be simulated in the following manner:

  i. The source of the simulated pool fire must be a hydrocarbon fuel with a flame temperature of 870 ± 56 °C (1600 ± 100 °F), throughout the duration of the test;

  ii. A square bare plate with thermal properties equivalent to the material of manufacture of the tank car must be used. The plate dimensions must be at least 305 x 305 mm (12 x 12 in.) by nominal 15.9 mm (5/8 in.) thick. The bare plate must be instrumented with not less than nine thermocouples to record the thermal response of the bare plate. The thermocouples must be attached to the surface not exposed to the simulated pool fire and must be divided into nine equal squares with a thermocouple placed in the centre of each square;

  iii. The pool-fire simulator must be manufactured in a manner that results in total flame engulfment of the front surface of the bare plate. The apex of the flame must be directed at the centre of the plate;

  iv. The bare plate holder must be manufactured so that the only heat transfer to the back side of the bare plate is by heat conduction through the plate and not by other heat paths;

  v. Before the bare plate is exposed to the simulated pool fire, none of the temperature recording devices may indicate a plate temperature in excess of 37.8 °C (100 °F) nor less than 0 °C (32 °F); and

  vi. A minimum of two thermocouples must indicate 427 °C (800 °F) after 13 ± 1 min of simulated pool-fire exposure.

b. A thermal protection system must be tested in the simulated pool-fire environment described in clause D1.1.1 a. in the following manner:

  i. The thermal protection system must cover one side of a bare plate as described in clause D1.1.1 a. ii;

  ii. The non-protected side of the bare plate must be instrumented with not less than nine thermocouples placed as described in clause D1.1.1 a. ii to record the thermal response of the plate;

  iii. Before exposure to the pool-fire simulation, none of the thermocouples on the thermal protection system configuration may indicate a plate temperature in excess of 37.8 °C (100 °F) nor less than 0 °C (32 °F);

iv. The entire surface of the thermal protection system must be exposed to the simulated pool-fire environment;

v. A pool-fire simulation test must run for a minimum of 100 min. The thermal protection system must retard the heat flow to the plate so that none of the thermocouples on the non-protected side of the bare plate indicate a plate temperature in excess of 427 °C (800 °F); and

vi. A minimum of three consecutive successful pool-fire simulation tests must be performed for each thermal protection system.

D1.1.2. Simulated Torch-fire Test

a. A torch-fire environment must be simulated in the following manner:

i. The source of the simulated torch fire must be a hydrocarbon fuel with a flame temperature of 1200 ± 56 °C (2200 ± 100 °F), throughout the duration of the test. Furthermore, torch velocities must be 64 ± 16 km/h (40 ± 10 mph) throughout the duration of the test;

ii. A square bare plate with thermal properties equivalent to the material of manufacture of the tank car must be used. The plate dimensions must be at least 1219 x 1219 mm (48 x 48 in.) by nominal 15.9 mm (5/8 in.) thick. The bare plate must be instrumented with not less than nine thermocouples to record the thermal response of the bare plate. The thermocouples must be attached to the surface not exposed to the simulated torch fire and must be divided into nine equal squares with a thermocouple placed in the centre of each square;

iii. The bare plate holder must be manufactured so that the only heat transfer to the back side of the bare plate is by heat conduction through the plate and not by other heat paths. The apex of the flame must be directed at the centre of the plate;

iv. Before the bare plate is exposed to the simulated torch fire, none of the temperature recording devices may indicate a plate temperature in excess of 37.8 °C (100 °F) or less than 0 °C (32 °F); and

v. A minimum of two thermocouples must indicate 427 °C (800 °F) after 4 min ± 30 s of simulated torch-fire exposure.

b. A thermal protection system must be tested in the simulated torch-fire environment described in clause D1.1.2 a. in the following manner:

i. The thermal protection system must cover one side of a bare plate as described in clause D1.1.2 a. ii;

ii. The non-protected side of the bare plate must be instrumented with not less than nine thermocouples placed as described in clause D1.1.2 a. ii. to record the thermal response of the plate;

iii. Before exposure to the torch-fire simulation, none of the thermocouples on the thermal protection system configuration may indicate a plate temperature in excess of 37.8 °C (100 °F) nor less than 0 °C (32 °F);

iv. The entire surface of the thermal protection system must be exposed to the simulated torch-fire environment;

v. A torch-fire simulation test must be run for a minimum of 30 min. The thermal protection system must retard the heat flow to the plate so that none of the thermocouples on the non-protected side of the bare plate indicate a plate temperature in excess of 427 °C (800 °F); and

vi. A minimum of two consecutive successful torch-fire simulation tests must be performed for each thermal protection system.

APPENDIX E - SCHEDULES

SCHEDULE 1 – SPECIAL PROVISIONS

This schedule lists the special provisions that apply to dangerous goods and that correspond to the number set out in column 6 of Schedule 2. For any given dangerous goods listed in Schedule 2 only the container types listed in the applicable special provision must be used. When more than one container type is authorized in one or more applicable special provision, the container selected must be listed in the applicable special provision and must conform to all other applicable requirements of this standard.

1. The dangerous goods may be handled, offered for transport, or transported in a metal railway vehicle that is closed and sift-proof.
2. The dangerous goods may be handled, offered for transport, or transported in a Class 105, 111, 112, 114, 115, 117, 120, AAR 203W, AAR 206W, or AAR 211W tank car or a Class 106 or 110 ton container.
3. The dangerous goods may be handled, offered for transport, or transported in a Class 105, 111, 112, 114, 115, 117, 120, or AAR 206W tank car or a Class 106 or 110 ton container.
4. The dangerous goods may be handled, offered for transport, or transported in a Class 105, 112, 114, or 120 fusion-welded tank car or a Class 106 or 110 ton container.
5. The dangerous goods may be handled, offered for transport, or transported in a Class 105 tank car.
6. The dangerous goods may be handled, offered for transport, or transported in a Class 106 ton container.
7. The dangerous goods may be handled, offered for transport, or transported in a Class 106 or 110 ton container.
8. The dangerous goods may be handled, offered for transport, or transported in a Class 112 tank car.
9. The dangerous goods may be handled, offered for transport, or transported in a Class 114 or 120 tank car.
10. The tank car must conform to the following requirements:

a. The tank car must be a:
   - i. Specification 105A300W tank car;
   - ii. Specification 105A500W tank car; or
   - iii. Specification 105A500W tank car equipped with the cover plates, pressure-relief devices, vent valves, and loading and unloading valves that are required on a Specification 105A300W tank car;

b. The tank car must be manufactured from nickel-clad or lead-lined steel plate;

c. The tank car must have nickel cladding or lead lining on the inside of the tank;

d. At least 20% of the required minimum total thickness of the tank car tank must be nickel cladding;

e. Nickel cladding must conform to ASTM B162;

f. Lead lining must be equal to or greater than 4.78 mm (0.188 in.) in thickness;

g. Service equipment in contact with the dangerous goods must be lined or manufactured from metal compatible with the dangerous goods;

h. The maximum filling density must be 300% and the minimum filling density must be 287%;

i. The maximum water capacity of the tank car must be:

   i. 9 253 kg (20 400 lb) for a Specification 105A300W tank car; and

   ii. 16 964 kg (37 400 lb) for a Specification 105A500W tank car;

j. The maximum quantity of dangerous goods in the tank car must be:

   i. 27 216 kg (60 000 lb) in a Specification 105A300W tank car; and

   ii. 49 895 kg (110 000 lb) in a Specification 105A500W tank car;

k. A tank car built after December 31, 1990 must be equipped with a tank-head puncture-resistance system that conforms to the requirements set out in clause 8.2.8 or to the corresponding requirements in effect at the time of installation; and

l. Except as provided in clause 10.5.1.2 c. a tank car manufactured after January 15, 2015 and used in the handling, offering for transport or transporting of bromine or bromine solutions must conform to the applicable authorized tank car specification listed in the table in clause 10.5.1.2 b.

11. The dangerous goods may be handled, offered for transport, or transported in a Class 105J tank car, which must conform to the following requirements:

a. The tank car must have a tank test pressure equal to or greater than 2068 kPa (300 psi);

b. In determining outage, the temperature of the dangerous goods, the solubility of inert gas padding in ethylene oxide, and the partial pressure exerted by the gas padding must be taken into account;

c. The tank car must be:

   i. equipped with a reclosing pressure-relief device having a start-to-discharge pressure of 517 kPa (75 psi);

   ii. padded with dry nitrogen or other suitable inert gas that is:

      A. of sufficient quantity to render the vapour space of the tank non-flammable up to 40.6 °C (105 °F); and

      B. free of impurities that may cause the ethylene oxide to polymerize, decompose, or undergo other violent chemical reactions;

iii. equipped with a thermometer well, if the tank car was manufactured after December 30, 1971; and

iv. equipped with packing and gaskets that are manufactured of materials that do not react with or do not lower the auto-ignition temperature of the dangerous goods.

d. Neoprene, natural rubber, and asbestos gaskets are prohibited; and

e. No part of the tank car and its service equipment, normally in contact with the dangerous goods, shall be manufactured of copper, silver, mercury, magnesium, or any of their alloys.

12. (RESERVED)

13. If the dangerous goods are in dispersion in organic liquid, the organic liquid must have a flash point greater than 50 °C (122 °F).

14. The container must be manufactured of steel.

15. The ton container must not be equipped with pressure-relief devices, and the openings for pressure-relief devices must be plugged or blank flanged.

16. The container must be manufactured of:

a. nickel or stainless steel; or

b. steel that is lined with nickel, stainless steel, lead, or other such corrosion-resistant metallic material.

17. The tank must not be equipped with bottom outlets.

18. The tank car tank must have a test pressure equal to or greater than 2068 kPa (300 psi).

19. Each container except a tank car or a ton container must be insulated with an insulating material so that the overall thermal conductance at 15.6 °C (60 °F) is equal to or less than 1.53 kJ/h·m^{2}·°C (0.075 Btu/h·ft.^{2}·°F). Insulating materials must not promote corrosion of steel when wet.

20. The container must be protected from corrosion:

a. by lining or coating the container with a non-metallic lining or coating compatible with the dangerous goods; or

b. by manufacturing the container to a thickness that provides an allowance for the corrosive effects of the dangerous goods such that no danger to public safety occurs or may reasonably be expected to occur.

21. The dangerous goods in the container must be completely covered with nitrogen, inert gas, or other inert materials.

22. The dangerous goods may be handled, offered for transport, or transported in an open steel container.

23. The tank must be manufactured of steel and:

a. lined or coated with a non-metallic lining or coating compatible with the dangerous goods; or

b. if the tank is not so lined or coated, the dangerous goods in the tank must be inhibited so that the corrosive effect on the steel is not greater than that of hydrofluoric acid of 65% concentration and the tank must be passivated before being used in the handling, offering for transport, or transporting of dangerous goods, including being re-passivated if cleaned with water.

24. The container must be manufactured of nickel or nickel-copper alloy or steel that is clad with nickel or nickel-copper alloy.

25. The tank must:

a. be insulated with a material of a thickness equal to or greater than 99.1 mm (3.9 in.) except that the thickness of the insulation may be reduced to 50.8 mm (2 in.) over exterior heater coils;

b. not be equipped with interior heating coils; and

c. after unloading, contain a padding of inert gas that covers the dangerous goods or be filled with water.

26. The tank must:

a. have a minimum tank test pressure of 1379 kPa (200 psi); and

b. contain a padding of dry inert gas at a pressure equal to or less than 103 kPa (15 psi).

27. The container must be manufactured of stainless steel.

28. Each tank car manufactured before January 15, 2015 must be a Class 105J tank car that:

a. has a tank test pressure equal to or greater than 3447 kPa (500 psi); and

b. is equipped with a reclosing pressure-relief device with a start-to-discharge pressure of 1034 kPa (150 psi).

29. Valves and pressure-relief devices that are in contact with the dangerous goods must be manufactured of materials that will not cause the formation of acetylides.

30. Pressure-relief devices must be equipped with stainless steel or platinum rupture discs.

31. The tank must not be equipped with interior heater coils, and a tank car must be equipped with a reclosing pressure-relief device with a start-to-discharge pressure equal to or less than 1551 kPa (225 psi).

32. The tank must be manufactured of stainless steel or aluminum.

33. The dangerous goods may be handled, offered for transport, or transported in an open-top, sift-proof railway vehicle.

34. The dangerous goods may be handled, offered for transport, or transported in a water-tight, sift-proof, closed-top, metal-covered hopper car that is equipped with a venting arrangement, including flame arrestors.

35. The dangerous goods may be handled, offered for transport, or transported in a water-tight, sift-proof, closed-top, metal-covered hopper car if the particle size of the dangerous goods is equal to or greater than 149 μm.

36. The dangerous goods may be handled, offered for transport, or transported in a Class 115A tank car that is equipped with:

a. a safety vent that has a diameter equal to or greater than 305 mm (12 in.); and

b. a rupture disc that has a start-to-discharge pressure equal to or less than 310 kPa (45 psi).

37. The dangerous goods may be handled, offered for transport, or transported in a covered hopper car with nitrogen padding.

38. The dangerous goods may be handled, offered for transport, or transported in a Specification 106A500X ton container that is not equipped with any type of pressure-relief device. The ton container must be filled to an outage capable of preventing the tank from becoming liquid full at 54.4 °C (130 °F).

39. Each tank car manufactured before January 15, 2015 of this standard must:

a. be a Class 105A tank car;

b. have a minimum tank test pressure of 3447 kPa (500 psi); and

c. be equipped with a reclosing pressure-relief device that has a start-to-discharge pressure equal to 1551 kPa (225 psi).

40. The tank must:

a. be equipped with gas-tight valve protection caps;

b. have a minimum tank test pressure of 3447 kPa (500 psi);

c. be filled to an outage capable of preventing the tank from becoming liquid full at 54.4 °C (130 °F); and

d. in the case of a Class 110A ton container, be manufactured of stainless steel.

41. The tank car must be a Class 105 tank car that:

a. is equipped with exterior heating coils that are fusion-welded to the tank shell and that have been post-weld heat treated;

b. has a tank test pressure equal to or greater than 2068 kPa (300 psi);

c. is filled such that the outage must be equal to or greater than 5% at a product temperature equal to 98 °C (208 °F); and

d. is loaded when the dangerous goods are in liquid form and transported only after the dangerous goods are in solid form.

42. The dangerous goods may be handled, offered for transport, or transported in a sift-proof, water-tight, metal-covered hopper car.

43. (RESERVED)

44. The tank car must conform to the applicable requirements of clause 10.5.1.

45. Each tank car manufactured before January 15, 2015 must be a Class 105S, 112J, 114J, or 120S tank car that:

a. has a tank test pressure equal to or greater than 2068 kPa (300 psi); and

b. is equipped with a reclosing pressure-relief device with a start-to-discharge pressure equal to 1034 kPa (150 psi).

46. The dangerous goods may be handled, offered for transport, or transported in a Class 105, 111, 112, 114, or 120 tank car that:

a. has a tank test pressure equal to or greater than 414 kPa (60 psi); and

b. is equipped with welded heater pipes designed for a test pressure of 3447 kPa (500 psi).

47. If hydrogen peroxide solution with more than 40% hydrogen peroxide, the tank must be equipped with venting devices, including filters, and the venting devices must be liquid-tight at pressures equal to or less than 138 kPa (20 psi).

48. Containers other than tank cars and ton containers are prohibited.

49. Bottom outlets are prohibited on a tank car that is or may be used in the handling, offering for transport, or transporting of sulphuric acid in concentrations greater than 65.25%, except a tank car with bottom outlets may be used for sulphuric acid in concentrations greater than 65.25% if the tank car conforms to the following conditions:

a. The tank car conforms to a Specification 111A100W2 tank car and is equipped with a bottom outlet that conforms to the requirements set out in clause 8.3.10 and par. E9.0, of the AAR *Specifications for Tank Cars* publication;

b. The tank car forms part of a train, commonly known as a "unit train," that:

    i. is comprised only of motive power units, tank cars, and possibly a caboose;

    ii. is not switched during transport;

    iii. travels from a single consignor to a single consignee; and

    iv. is comprised of tank cars that contain only sulphuric acid in concentrations greater than 65.25%.

c. If, during transport, one of the tank cars referred to in clause 49 a. requires repair or has been repaired, the tank car may be separated from the "unit train" and proceed to destination in a regular freight train;

d. The bottom outlet cap must be secured;

e. The bottom outlet cap must be locked in place with a retractable pin that engages the hammer lugs if the outlet cap is equipped with hammer lugs;

f. The bottom outlet cap, when secured and locked, must provide a liquid-tight seal that is maintained, under normal conditions of transport, including handling, throughout the time that the dangerous goods are transported between consignor and consignee; and

g. Before offering the dangerous goods for transport, the rupture discs must be removed and inspected on a representative sampling of the tank cars.

50. The container must be protected from corrosion:

a. by lining or coating the container with a non-metallic lining or coating compatible with the dangerous goods; or

b. by manufacturing the container to a thickness that provides an allowance for the corrosive effects of sulphuric acid in concentrations up to 65.25% or spent sulphuric acid in concentrations up to 65.25%.

51. The tank must be filled to a filling density less than or equal to 125%.

52. The dangerous goods may be handled, offered for transport, or transported in a Class 105 tank car that is filled to a filling density less than or equal to 124%.

53. The dangerous goods may be handled, offered for transport, or transported in a Class 106 ton container that is:

a. filled to a filling density less than or equal to 110%;

b. nickel clad; and

c. equipped with pressure-relief devices incorporating a fusible plug with a yield temperature of 79.4 °C (175 °F).

54. The tank must be filled to a filling density less than or equal to 120%.

55. The minimum outage must be such that the liquefied portion of the gas does not completely fill the tank prior to reaching the greater of either the setting of the pressure-regulating valve with the lowest setting that is fitted on the tank car or 2413 kPa (350 psi).

56. The tank car must conform to the following requirements:

a. The tank plates, manway nozzles and, subject to clause 56 c., anchorages of the tank must be manufactured of carbon steel that conforms to:

    i. ASTM A516/A516M, Grade 55/380, 60/415, 65/450, or 70/485 steel that conforms to the Charpy V-notch impact test requirements of ASTM A20/A20M, in longitudinal direction of rolling; or

    ii. AAR TC128, Grade B steel that conforms to the Charpy V-notch impact test requirement of ASTM A370. The test must be conducted at a temperature equal to or less than -46 °C (-50 °F) in the longitudinal direction of rolling. The minimum average energy absorption result for three test specimens must be 20 J (15 ft.-lb.) and the minimum energy absorption result for any individual test specimen must be 13.5 J (10 ft.-lb.);

b. Production welded test plates must:

    i. be prepared in conformance with the requirements set out in par. W3.0, of the AAR *Specifications for Tank Cars* publication;

    ii. include impact test specimens of the weld metal and of base metal from the heat-affected zone that are prepared and tested in conformance with the requirements set out in par. W8.0, of the AAR *Specifications for Tank Cars* publication; and

    iii. conform to the same impact requirements as the plate material;

c. Anchor legs may be manufactured of stainless steel, ASTM A240/A240M Type 304, 304L, 316, or 316L, in which case impact tests are not required;

d. The tank car tank must be insulated such that the overall thermal conductance is equal to or less than 0.61 $kJ/h \cdot m^{2} \cdot °C$ (0.03 $Btu/h \cdot ft^{2} \cdot °F$);

e. The tank car must be equipped with:

   i. a reclosing pressure-relief device having a start-to-discharge pressure equal to or less than 75% of the tank test pressure;

   ii. a rupture disc set to burst at a pressure less than the tank test pressure and more than the reclosing pressure relief device start-to-discharge pressure;

   iii. pressure-relief devices that have a discharge capacity capable of preventing the pressure in the tank from exceeding 82.5% of the tank test pressure;

   iv. two regulating valves having start-to-discharge pressures equal to or less than:

      A. 2413 kPa (350 psi) on a Specification 105A500W tank car; and

      B. 2758 kPa (400 psi) on a Specification 105A600W tank car; and

   v. regulating valves and pressure-relief devices that have their discharge directed outside the protective housing;

f. The tank car must have a tank test pressure equal to or greater than 3447 kPa (500 psi).

57. The tank must be filled to a filling density equal or greater than 80.1% and less than or equal to 89% at a maximum pressure of 621 kPa (90 psi).

58. The tank must be filled to a filling density equal to or greater than 53.6% and less than or equal to 59.6% at a maximum pressure of 724 kPa (105 psi).

59. The tank car must conform to the following requirements:

a. The tank car must be a Specification 105J600W tank car;

b. All plates for the tank car tank must be manufactured of steel listed in clause 59 b. ii. and service equipment must be manufactured of steel listed in clause 59 b. i. or ii.:

   i. Stainless steel that conforms to ASTM A240/A240M, Type 304, 304L, 316, or 316L, in which case impact tests are not required; or

   ii. Steel that conforms to ASTM A516/A516M, Grade 70/485, ASTM A537/A537M, Class 1, or AAR TC128, Grade B, in which case impact tests must be performed as follows:

      A. ASTM A516/A516M, Grade 70/485 and ASTM A537/A537M, Class 1 steel must conform to the Charpy V-notch impact test requirements of ASTM A20/A20M, in the longitudinal direction of rolling; and

      B. AAR TC128, Grade B steel must conform to the Charpy V-notch impact test requirement of ASTM A370. The test must be conducted at a temperature equal to or less than -46 °C (-50 °F) in the longitudinal direction of rolling. The minimum average energy absorption result for three test specimens must be

20 J (15 ft.-lb.) and the minimum energy absorption result for any individual test specimen must be 13.5 J (10 ft.-lb.);

c. Production welded test plates must:

   i. be prepared in conformance with the requirements set out in par. W3.0, of the AAR *Specifications for Tank Cars* publication;

   ii. include impact test specimens of the weld metal and of base metal from the heat-affected zone that are prepared and tested in conformance with the requirements set out in par. W8.0, of the AAR *Specifications for Tank Cars* publication; and

   iii. conform to the same impact requirements as the plate material;

d. The tank car must be equipped with at least one reclosing pressure-relief device that conforms to the requirements set out in clause 8.2.6;

e. The discharge from each pressure-relief device must be directed outside the protective housing;

f. Excess-flow valves must be installed under all liquid and vapour valves;

g. A thermometer well may be installed;

h. A gauging device may be installed;

i. A pressure gauge may be installed;

j. Aluminum, copper, silver, zinc, or an alloy of any of these metals must not be used in the manufacture of the tank car tank or any part of the service equipment that is in contact with the dangerous goods;

k. The jacket of the tank car must be stencilled adjacent to the stencil for water capacity, as follows:

MINIMUM OPERATING TEMPERATURE — °C (°F)

or

MINIMUM OPERTAING TEMPERATURE / TEMPÉRATURE MINIMALE EN SERVICE — °C (°F)

l. The tank car and insulation must be designed to prevent the vapour pressure of the dangerous goods from reaching the start-to-discharge pressure of the pressure-relief device on or before thirty days after loading the tank car. The conditions to be considered include an ambient temperature equal to 32.2 °C (90 °F) and the tank car filled to its maximum allowable filling density.

60. The liquefied gas must be loaded so that the outage is equal to or greater than 2% of the total capacity of the tank at one of the following reference temperatures:

a. 46.1 °C (115 °F) for a non-insulated tank;

b. 43.3 °C (110 °F) for tanks having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance less than or equal to 10.22 kJ/h·m^{2}·°C (0.5 Btu/h·ft.^{2}·°F); and

c. 40.6 °C (105 °F) for an insulated tank when the overall thermal conductance is equal to or less than the minimum required of a Class 105 or 120.

61. For liquefied petroleum gas and anhydrous ammonia loaded in tank cars, during the winter months of November through March, the following winter reference temperatures may be used if:

a. the tank car is shipped directly to a consumer for unloading and not stored in transit;

b. the offeror of the tank car informs each customer that winter reference temperatures were used at the time that the tank car was filled;

c. the tank car is unloaded as soon as possible after the month of March in order to retain the specified outage and to prevent a release of dangerous goods which might occur due to the tank car becoming liquid full at higher temperatures; and

d. the winter reference temperatures are:

   i. 38 °C (100 °F) for a non-insulated tank car;

   ii. 32 °C (90 °F) for a tank car having a thermal protection system incorporating a metal jacket that provides at 15.6 °C (60 °F) an overall thermal conductance less than or equal to 10.2 kJ/h·m^{2}·°C (0.50 Btu/h·ft.^{2}·°F); or

   iii. 29 °C (85 °F) for an insulated tank car when the overall thermal conductance is equal to or less than the minimum required of a Class 105 or 120.

62. The tank car must conform to the following requirements:

a. The tank car must be a Specification 105J600W tank car and be designed for loading at a temperature equal to or less than -45.6 °C (-50 °F);

b. All plates for the tank car tank must be manufactured of steel listed in clause 62 b. ii., and service equipment must be manufactured of steel listed in clause 62 b. i. or b. ii.:

   i. Stainless steel that conforms to ASTM A240/A240M, Type 304, 304L, 316, or 316L, in which case impact tests are not required; or

   ii. Steel that conforms to ASTM A516/A 516M, Grade 70/485, ASTM A537/A537M, Class 1, or AAR TC128, Grade B, in which case impact tests must be performed as follows:

      A. ASTM A516/A516M, Grade 70/485 and ASTM A537/A537M, Class 1 steel must conform to the Charpy V-notch impact test requirements of ASTM A20/A20M, in the longitudinal direction of rolling; and

      B. AAR TC128, Grade B steel must conform to the Charpy V-notch impact test requirement of ASTM A370. The test must be conducted at a temperature equal to or less than -46 °C (-50 °F) in the longitudinal direction of rolling. The minimum average energy absorption result for three test specimens must be 20.3 J (15 ft.-lb.) and the minimum energy absorption result for any individual test specimen must be 13.5 J (10 ft.-lb.);

c. Production welded test plates must:

   i. be prepared in conformance with the requirements set out in par. W3.0, of the AAR *Specifications for Tank Cars* publication;

  ii. include impact test specimens of the weld metal and of base metal from the heat-affected zone that are prepared and tested in conformance with the requirements set out in par. W8.0, of the AAR *Specifications for Tank Cars* publication; and
  iii. conform to the same impact requirements as the plate material;

d. Reclosing pressure-relief devices must be trimmed with nickel-copper alloy or other material approved by the Executive Director and be equipped with a rupture disc of silver, polytetrafluoroethylene-coated nickel-copper alloy, or tantalum. Pressure-relief devices must be equipped with a suitable auxiliary valve for the purpose of venting the space between the rupture disc and the relief valve;

e. The discharge from each pressure-relief device must be directed outside the protective housing;

f. Loading and unloading valves must be:
  i. trimmed with nickel-molybdenum alloys UNS N10001 or N10002, nickel-copper, or other material approved by the Executive Director; and
  ii. identified as "Vapours" or "Vapours/Vapeurs," "Liquid" or "Liquid/Liquide";

g. Excess-flow valves or spring loaded check valves must be installed under all liquid and vapour valves, but an excess-flow valve must not be installed in conjunction with a pressure-relief device;

h. A thermometer well may be installed;

i. A gauging device may be installed;

j. A sump must be installed in the bottom of the tank under the liquid pipes;

k. All gaskets must be made of, or coated with, polytetrafluoroethylene or other materials approved by the Executive Director;

l. The tank car may be equipped with exterior cooling coils on top of the shell;

m. The jacket of the tank car must be stencilled adjacent to the stencil for water capacity, as follows:

MINIMUM OPERATING TEMPERATURE — °C (°F)
or
MINIMUM OPERTAING TEMPERATURE / TEMPÉRATURE MINIMALE EN SERVICE — °C (°F)

n. The tank car and insulation must be designed to prevent the vapour pressure of the dangerous goods from reaching the start-to-discharge pressure of the pressure-relief device on or before thirty days after loading the tank car. The conditions to be considered include an ambient temperature equal to 32.2 °C (90 °F) and the tank car filled to its maximum allowable filling density;

o. The tank car must be unloaded to such an extent that the vapour pressure of the dangerous goods remaining in the tank, at a reference temperature equal to 32.2 °C (90 °F), will not reach the start-to-discharge pressure of the pressure-relief device;

p. The auxiliary valve on the pressure-relief device must be closed during transport;

q. In addition to the above requirements and except as provided in special provision 83, a tank car manufactured after January 15, 2015 and used in the handling, offering for transport or transporting of hydrogen chloride, refrigerated liquid must conform to specification 105J600W and must be equipped with a tank-head puncture-resistance system that conforms to clause 8.2.8. Clause 8.2.8.3 does not apply.

63. The tank car must conform to the following requirements:

a. The interior pipes of the loading and unloading valves and sampling valves, as well as the gauging device if it provides a means for passage of the dangerous goods from the interior to the exterior of the tank must be equipped with excess-flow valves or spring loaded check valves. If the opening for passage of the dangerous goods through the gauging device is less than 1.52 mm (0.060 in.) in diameter, an excess-flow valve is not required.

b. The cover of the protective housing must be provided with an opening that is located above each pressure-relief device. The opening must be provided with a weatherproof cover designed for vertical discharge. The opening with weatherproof cover must be concentric with the discharge of the pressure-relief device and must have an area equal to or greater than the valve outlet area.

64. The tank car must be a Class 105 tank car that:

a. is insulated with 50.8 mm (2 in.) glass fibre placed over 50.8 cm (2 in.) of ceramic fibre, if the tank car was manufactured after September 30, 1991;

b. has a tank test pressure equal to or greater than 3447 kPa (500 psi);

c. has excess-flow valves or spring loaded check valves on the interior pipes of liquid discharge valves; and

d. in addition to the above requirements and except as provided in special provision 8, a tank car manufactured after January 15, 2015 and used in the handling, offering for transport or transporting of chlorine must conform to specification 105J600W and must be equipped with a tank-head puncture-resistance system that conforms to clause 8.2.8. Clause 8.2.8.3 does not apply.

65. The tank car must be a Specification 105J600W tank car or a Class 106 or 110 ton container. In addition, the tank must conform to the following requirements:

a. In the case of a Specification 105J600W tank car:

   i. the water content of the dangerous goods must be equal to or less than 0.10% by mass; and

   ii. the outage must be equal to or greater than 1% of the total volumetric capacity of the tank at the reference temperature of 40.6 °C (105 °F);

b. In the case of a Class 106 or 110 ton container:

   i. the ton container must be equipped with one or more pressure-relief devices of the fusible plug type having a yield temperature equal to or less than 76.7 °C (170 °F) and equal to or greater than 69.4 °C (157 °F). Each device must be resistant to extrusion of the fusible alloy and leak-tight at 54.4 °C (130 °F);

    ii. the valve outlets must be sealed by a threaded solid plug; and

    iii. all valves must be protected by a metal cover, and the maximum filling density is 68%.

c. In addition to the above requirements and except as provided in special provision 83 a tank car manufactured after January 15, 2015 and used in the handling, offering for transport or transporting of hydrogen sulphide must conform to specification 105J600W and must be equipped with a tank-head puncture-resistance system that conforms to clause 8.2.8. Clause 8.2.8.3 does not apply.

66. The tank car must conform to the following requirements:

a. Subject to clause 66 b. the tank car must have a head puncture-resistance system, a metal jacket, and a tank test pressure equal to or greater than 1379 kPa (200 psi), except that:

    i. no metal jacket is required if:

        A. the tank test pressure is equal to or greater than 2344 kPa (340 psi); or

        B. the tank shell and head are manufactured from AAR TC128, Grade B steel, normalized.

    ii. a higher tank test pressure is required if such higher tank test pressure is otherwise specified in this standard.

b. When a reference to this special provision is made in column 6 of the table in Schedule 2 for generic shipping names, the requirements of clause 66 a. apply only to the following generic shipping names and descriptions of dangerous goods:

    i. Organochlorine pesticide, solid, toxic, or organochlorine pesticide, liquid, toxic, flammable, or organochlorine pesticide, liquid, toxic, if those pesticides include any one of the following chemicals or their solutions or mixtures: aldrin, chlordane, DDT, dieldrin, alpha-endosulfan, beta-endosulfan, endrin, heptachlor, isodrin, metoxychlor, pentachlorophenol, TDE, toxaphene, 2,4,5-trichlorophenol, or 2,4,6-trichlorophenol;

    ii. Chloroanilines, solid containing p-chloroaniline;

    iii. Chlorocresols, solid containing6 p-chloro-m-cresol;

    iv. Flammable liquid, n.o.s. containing 2-chloroethyl vinyl ether or 1,2-dichloroethane or 1,2-dichloropropane or 1,3-dichloropropene or 1,2,4-trichlorobenzene or 1,1,2-trichloroethane;

    v. Chlorophenols, liquid containing o-chlorophenol;

    vi. Toxic liquid, n.o.s. containing 3-chloropropionitrile or m-dichlorobenzene or p-dichlorobenzene or hexachloropropene or tetrachloroethane;

    vii. Dibromochloropropanes containing 1,2-dibromo-3-chloropropane;

    viii. Toxic liquid, flammable, n.o.s. containing 1,4-dichloro-2-butene; and

    ix. Toxic solid, n.o.s. containing 2,4-diclorophenol or kepone or 1,2,4,5-tetrachlorobenzene.

67. The dangerous goods may be handled, offered for transport, or transported in a container that conforms to the following requirements:

a. The container must be:

   i. a Class 105, 111, 112, 114, 115 or 117 tank car or a Specification AAR203W, AAR206W, or AAR211W tank car; or

   ii. a Class 106 or 110 ton container; or

b. A non-specification tank, other than a tank car, equivalent in structural design and accident damage resistance to a specification container;

68 Dangerous goods that meet the definition of solid elevated temperature dangerous goods are exempted from all requirements of this standard.

69. The dangerous goods may be handled, offered for transport, or transported in a tank car that conforms to the following requirements:

a. A tank car containing a flammable cryogenic liquid must not be shipped unless the tank car was loaded by, or with the consent of, the owner of the tank car;

b. The amount of flammable cryogenic liquid loaded into a tank car must be determined either by direct measurement or by calculation based on mass to verify that the tank has not been filled to a level in excess of the limits specified in special provision 69 f. The mass of any flammable cryogenic liquid loaded, except hydrogen, must be checked by the use of scales after disconnecting the loading line;

c. A tank car must not be loaded with any flammable cryogenic liquid:

   i. if the tank car already contains dangerous goods or other substance that is not compatible with the dangerous goods to be loaded;

   ii. that is colder than the design service temperature of the tank; or

   iii. if the average daily pressure rise in the tank exceeded 20.7 kPa (3 psi) during any prior shipment;

d. When a tank car containing a flammable cryogenic liquid is offered for transport:

   i. outage must be equal to or greater than 0.5% and the liquid level must be below the inlet of the pressure-relief valve or pressure-control valve at the start-to-discharge pressure setting of the valve, with the tank car in a level attitude; and

   ii. the absolute pressure in the annular space must be less than 10 Pa (75 μm of mercury);

e. A flammable cryogenic liquid must be loaded into a tank car at such a temperature that the average daily pressure rise during transport will be equal to or less than 20.7 kPa (3 psi);

f. A Class 113 tank car is authorized for the shipment of ethylene, methane, natural gas or hydrogen (minimum 95% parahydrogen) in the state of cryogenic liquids. Such a tank car must be loaded and shipped in accordance with the applicable requirements set out in the following table:

Pressure-control Valve Setting or Relief-valve Setting

Relief-valve Setting	**113D60W*** **113C60W***	**113C120W**	**113D120W***	**113A175W*** **113A60W**
	Ethylene	**Ethylene**	**Ethylene**	**Hydrogen**
Design service temperature	-162.2°C (-260°F)	-162.2°C (-260°F)	-103.9°C (-155°F)	-252.8°C (-423°F)
Maximum permitted filling density (% by mass)	52.8 (at 310 kPa [45 psi] maximum start-to-discharge)	50.7 (at 517 kPa [75 psi] maximum start-to-discharge)	51.1 (at 517 kPa [75 psi] maximum start-to-discharge)	6.60 (at 117 kPa [17 psi] maximum start-to discharge)
Maximum pressure when offered for transport, kPa (psi)	68.9 (10)	68.9 (10)	137.9 (20)	—

Relief-valve Setting	**113C120W**	**113C140W**	**113C140W**
	Methane or Natural Gas	**Ethylene**	**Methane or Natural Gas**
Design service temperature	-162.2°C (-260°F)	-162.2°C (-260°F)	-162.2°C (-260°F)
Maximum permitted filling density (% by mass)	37.3 (at 517 kPa [75 psi] maximum start-to-discharge)	50.1 (at 620 kPa [90 psi] maximum start-to-discharge)	36.8 (at 620 kPa [90 psi] maximum start-to-discharge)
Maximum pressure when offered for transport, kPa (psi)	68.9 (10)	68.9 (10)	68.9 (10)

*Tank car specification may continue in use, but new construction is not authorized.

g. Each shipment of Division 2.1 Dangerous Goods must be monitored to determine the average daily pressure rise in the tank car tank. If the average daily pressure rise during any shipment is greater than 21 kPa (3 psi) per day, the tank car must be retested for thermal integrity before any subsequent shipment. Either of the following alternative thermal integrity retests may be used:

   i. Pressure Rise Retest — The pressure rise in the tank must not exceed 34.5 kPa (5 psi) in 24 h. If the pressure rise retest is performed, the absolute pressure in the annular space of the loaded tank car must not exceed 10 Pa (75 μm of mercury) at the beginning of the retest and must not increase more than 3.33 Pa (25 μm of mercury) during the 24 h period; or

   ii. Calculated Heat Transfer Rate Retest — The insulation system must be performance tested as specified in clause 8.6.3. If the calculated heat transfer rate retest is performed, the absolute pressure in the annular space of the loaded tank car must not exceed 10 Pa (75 μm of mercury) at the beginning of the retest and must not increase more than 3.33 Pa (25 μm of mercury) during the 24 h period. The calculated heat transfer rate in 24 h must not exceed:

      A. 120% of the appropriate standard heat transfer rate specified in clause 8.6.24.1, for a Specification 113A60W, 113C120W or 113C140W tank car;

      B. 0.2707 kJ/kg/day (0.1164 Btu/day/lb.) of inner tank water capacity for a Specification 113A175W tank car;

      C. 0.7610 kJ/kg/day (0.3272 Btu/day/lb.) of inner tank water capacity for a Specification 113C60W and Specification 113D60W tank car; or

      D. 1.1025 kJ/kg/day (0.4740 Btu/day/lb.) of inner tank water capacity for a Specification 113D120W tank car;

h. If a Class 113 tank car fails either of the retests specified in clause 82 g. i. or ii, the tank car must be removed from service and must not be placed back in service until one of the applicable retests in clause 82. g. i. or ii, is completed successfully;

i. A rupture disc of a Class 113 tank car must be replaced every twelve months, and the replacement date stencilled on the car adjacent to marking for the pressure-relief device;

j. If a Class 113 tank car is used in the handling, offering for transport, or transporting of a flammable cryogenic liquid, an alternate pressure-relief device must be retested at the same time interval specified for the required pressure-relief device. The start-to-discharge pressure and vapour-tight pressure requirements for the alternate pressure-relief device must be as specified in clause 8.6.24.1. The alternate pressure-relief device values specified in clause 8.6.24 for the Specification 113C120W tank car apply to the Specification 113D120W tank car; and

k. A tank car transporting a flammable cryogenic liquid must not be:

   i. uncoupled while in motion;

   ii. coupled into with more force than is necessary to complete the coupling; or

   iii. struck by any railway vehicle moving under its own momentum.

70. Atmospheric gases, helium, and mixtures thereof, or cryogenic liquids may be handled, offered for transport, or transported in a tank car provided the tank car conforms to the following requirements, as applicable:

a. If the internal pressure is to be maintained at values equal to or less than 174 kPa (25.3 psi) during transport, the tank car must be a Class 113 tank car or a Specification AAR 204W tank car when authorized for such service by the Executive Director and the filling level of the dangerous goods is equal to or less than 95% of the volumetric capacity of the tank;

b. The conditions specified by the AAR for such tank cars;

c. The pressure setting for a pressure-control valve, if used, must be equal to or greater than 103 kPa (15 psi);

d. The absolute pressure in the annular space is less than 26.7 Pa (200 μm of mercury);

e. The internal tank pressure in a Specification AAR 204W at the time of offering for transport is equal to or less than 69 kPa (10 psi);

f. If the internal pressure is to be maintained at values greater than 174 kPa (25.3 psi) during transport, the tank car must be a Class 113 tank car loaded and shipped in accordance with the applicable requirements set out in the following table:

Relief-valve Setting	**113A90W**	**113A90W**	**113A90W**
	Nitrogen	**Oxygen**	**Argon**
Design service temperature	-195.5 °C (-320 °F)	-195.5 °C (-320 °F)	-195.5 °C (-320 °F)
Maximum permitted filling density (% by mass)	72.0 (at 414 kPa 60psi] maximum start-to-discharge)	104.0 (at 414 kPa [60 psi] maximum start-to-discharge)	126.0 (at 414 kPa [60 psi] maximum start-to discharge)
Maximum pressure when offered for transport, kPa (psi)	NA	NA	NA

g. A tank car transporting cryogenic liquid must not be:

i. uncoupled while in motion;

ii. coupled into with more force than is necessary to complete the coupling; or

iii. struck by any railway vehicle moving under its own motion.

71. The container for asbestos must conform to the general requirements of Section 4 of this standard. The asbestos must be handled, offered for transport, or transported in a rigid, watertight, and sift-proof container such as a portable tank or a hopper-type railway vehicle. Asbestos that is immersed or fixed in a natural or artificial binder material, such as cement, plastic, asphalt, resins, or mineral ore, and manufactured products containing asbestos are not subject to the requirements of this standard.

72. This dangerous goods is toxic by inhalation in Hazard Zone A.

73. This dangerous goods is toxic by inhalation in Hazard Zone B.

74. This dangerous goods is toxic by inhalation in Hazard Zone C.

75. This dangerous goods is toxic by inhalation in Hazard Zone D.

76. This dangerous goods is toxic by inhalation.

77. Liquefied petroleum gas must be odorized to allow detection of the liquefied petroleum gas in the atmosphere at any concentration above one-fifth of its lower explosive limit in air unless the addition of any odorant would be harmful to further use or processing of the liquefied petroleum gas.

78. The dangerous goods may be handled, offered for transport, or transported in a railway vehicle or a non-specification container. The container must be water-tight, sift-proof, and provided with a venting arrangement that is capable of preventing any accumulation of gaseous emissions that could endanger public safety. Before and during loading, the dangerous goods must be dry, must not come in contact with water, and must not be offered for transport if the temperature of the dangerous goods exceeds 40 °C (104 °F).

79. The pressure-relief devices on tank cars must have been qualified within the last five years. The pressure-relief devices on tank cars must be equipped with a stainless steel spring or a spring coated to protect against ammonia stress corrosion cracking.

80. Except as provided in special provision 83, for dangerous goods toxic by inhalation, tank cars manufactured after the January 15, 2015 must conform to specification 105J500W. When special provision 81 is also set out in schedule 2 for the specific dangerous goods a 112J500W is also authorized. Tank cars must be equipped with a tank-head puncture-resistance system that conforms to clause 8.2.8. Clause 8.2.8.3 does not apply.

81. Except as provided in special provision 83, for dangerous goods toxic by inhalation, tank cars manufactured after January 15, 2015 must conform to specification 112J500W. When special provision 80 is also set out in schedule 2 for the specific dangerous goods a 105J500W is also authorized. Tank cars must be equipped with a tank-head puncture-resistance system that conforms to clause 8.2.8. Clause 8.2.8.3 does not apply.

82. Except as provided in special provision 83, for dangerous goods toxic by inhalation, tank cars manufactured after January 15, 2015 must conform to specification

105J600W and must be equipped with a tank-head puncture-resistance system that conforms to clause 8.2.8. Clause 8.2.8.3 does not apply.

83. As an alternative to the tank car specifications authorized in special provisions 62, 64, 65, 80, 81, or 82 a tank car of the same authorized specification but of the next lower test pressure, as prescribed in column 3 of the table in clause 8.3.22 may be used provided that both of the following conditions are met:

a. The difference between the alternative and the required minimum plate thicknesses, based on the calculation using the formula in clause 8.3.6.1, must be added to the alternative tank car jacket and head shield. When the jacket and head shield are made from steel with a minimum tensile strength from 483 to 558 MPa (70 000 to 81 000 psi), but the required minimum plate thickness calculation is based on steel with a minimum tensile strength of 558 MPa (81 000 psi), the thickness to be added to the jacket and head shield must be increased by a factor of 1.157. Forming allowances for heads are not required to be considered when calculating thickness differences; and

b. The tank car jacket and head shields are manufactured from carbon steel plates as prescribed in clause 8.3.5. The steel must meet the Charpy requirements of par. 2.2.1.2 of the AAR *Specifications for Tank Cars* publication and head shields must be normalized after forming.

84. The tank must be filled to a filling density less than or equal to 104%.

85. Despite Clause 10.6.2.a, the tank car does not need to be grounded during loading and unloading as long as fire safety measures have been taken to prevent the exposure of the dangerous goods to fire hazards, including sources of ignition, intense heat and flammable materials.

86. The dangerous goods may be handled, offered for transport, or transported in a tank car in accordance with clause 10.5.6 or a Class 106 or 110 ton container.

87. If the free sulphur trioxide content in the dangerous goods is 30% or greater, the following requirements apply:

   i. The dangerous goods is toxic by inhalation in Hazard Zone B;

   ii. A tank car must be fusion-welded, conform to Class 105, 112, 114 or 120, and conform to the applicable requirements of clause 10.5.1;

   iii. Despite anything to the contrary in Special Provision 49, the tank must not be equipped with bottom outlets; and

   iv. Each container, except a tank car or a ton container, must be insulated with an insulating material so that the overall thermal conductance at 15.6 °C (60 °F) is equal to or less than 1.53 $kJ/h{\cdot}m^{2}{\cdot}°C$ (0.075 $Btu/h{\cdot}ft.^{2}{\cdot}°F$). Insulating materials must not promote corrosion of steel when wet.

SCHEDULE 2 – LIST OF DANGEROUS GOODS

LEGEND

Column 1	**Shipping Name and Description** — This column gives the shipping names for dangerous goods in alphabetical order within each primary class and within each packing group. The alphabetical order has been determined by ignoring all numerical digits and all lower case letters that precede the first capital letter in the shipping name. The most appropriate designation for the dangerous goods must be selected based on each class, UN number and packing group established per the classification requirements of clause 4.5.
Column 2	**Primary Class** — This column gives the primary class of the dangerous goods.
Column 3	**Subsidiary Class** — This column gives the subsidiary class(es), if applicable, of the dangerous goods.
Column 4	**UN Number** — This column gives the UN number assigned to the dangerous goods under the UN system.
Column 5	**Packing Group** — This column gives the packing groups of the dangerous goods.
Column 6	**Special Provisions** — This column gives the special provisions that apply to the dangerous goods.
Symbol P	The symbol P used in this schedule means that the handling, offering for transport, and transporting of the dangerous goods by rail is prohibited.

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Class 2.1 Dangerous Goods					
Dimethylamine, anhydrous	2.1		UN1032	—	5, 6, 8, 63
Ethylamine	2.1		UN1036	—	4, 63
Ethylene, refrigerated liquid	2.1		UN1038	—	69
Hydrogen, refrigerated liquid	2.1		UN1966	—	69
Methane, compressed or Natural gas, compressed, with high methane content	2.1		UN1971	—	5, 8, 9
Methane, refrigerated liquid or natural gas, refrigerated liquid, with high methane content	2.1		UN1972	—	69
Methylacetylene and propadiene mixture, stabilized	2.1		UN1060	—	4, 29, 63
Methylamine, anhydrous	2.1		UN1061	—	5, 6, 8, 63
Methyl chloride (Refrigerant Gas R 40	2.1		UN1063	—	5, 6, 8, 63
Petroleum gases, liquefied	2.1		UN1075	—	4, 61, 63, 77
Vinyl chloride, stabilized	2.1		UN1086	—	4, 29, 63
Vinyl fluoride, stabilized	2.1		UN1860	—	5, 58, 59, 63
Vinyl methyl ether, stabilized	2.1		UN1087	—	4, 29, 63
Dangerous Goods of Class 2.1, not listed above, non-cryogenic	2.1		—	—	4, 63
Class 2.2 Dangerous Goods					
Air, refrigerated liquid	2.2	5.1	UN1003	—	70

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Ammonia solution, relative density less than 0.880 at 15°C (59°F) in water, with more than 35% but not more than 50% ammonia	2.2		UN2073	—	5, 8, 9
Argon, refrigerated liquid	2.2		UN1951	—	70
Carbon dioxide, refrigerated liquid	2.2		UN2187	—	5, 55, 56
Gases, refrigerated liquid, n.o.s.	2.2		UN3158	—	70
Helium, refrigerated liquid	2.2		UN1963	—	70
Krypton, refrigerated liquid	2.2		UN1970	—	70
Neon, refrigerated liquid	2.2		UN1913	—	70
Nitrogen, compressed	2.2		UN1066	—	5, 8, 9
Nitrogen, refrigerated liquid	2.2		UN1977	—	70
Nitrous oxide, refrigerated liquid	2.2	5.1	UN2201	—	5, 14, 55, 56
Oxygen, refrigerated liquid	2.2	5.1	UN1073	—	70
Sulphur hexafluoride	2.2		UN1080	—	4, 84
Xenon, refrigerated liquid	2.2		UN2591	—	70
Dangerous Goods of Class 2.2, not listed above, non-cryogenic	2.2		—	—	4
Class 2.3 Dangerous Goods					
Ammonia, anhydrous	2.3	8	UN1005	—	5, 6, 8, 9, 60, 61, 75, 79, 80, 81, 83
Ammonia solution, relative density less than 0.880 at 15°C (59°F) in water, with more than 50% ammonia	2.3	8	UN3318	—	5, 6, 8, 9, 60, 75, 79, 80, 81, 83

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Boron trichloride	2.3	8	UN1741	—	5, 6, 17, 19, 74
Boron trifluoride	2.3	8	UN1008	—	4, 17, 19, 73
Chlorine	2.3	5.1, 8	UN1017	—	5, 6, 19, 51, 64, 73, 83
Chloropicrin and methyl bromide mixture, with more than 2% chloropicrin	2.3		UN1581	—	4, 17, 19, 73
Dangerous goods of Class 2.3, not specifically listed, meeting the definition of dangerous goods toxic by inhalation, Hazard Zone B	2.3		—	—	4, 19, 73, 82, 83
Dangerous goods of Class 2.3, not specifically listed, meeting the definition of dangerous goods toxic by inhalation, Hazard Zone C	2.3		—	—	4, 17, 19, 74, 80, 83
Dangerous goods of Class 2.3, not specifically listed, meeting the definition of dangerous goods toxic by inhalation, Hazard Zone D	2.3		—	—	4, 17, 19, 75, 80, 81, 83
Dinitrogen tetroxide (Nitrogen dioxide)	2.3	5.1, 8	UN1067	—	5, 7, 15, 19, 30, 40, 72, 80, 83
Ethylene oxide or Ethylene oxide with nitrogen, up to a total pressure of 1 MPa (10 bar) at 50°C	2.3	2.1	UN1040	—	11, 75, 80, 83
Hydrogen chloride, refrigerated liquid	2.3	8	UN2186	—	5, 14, 57, 62, 74, 83
Hydrogen sulphide	2.3	2.1	UN1053	—	5, 7, 17, 19, 63, 65, 73, 83

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Methyl bromide, with not more than 2% chloropicrin	2.3		UN1062	—	5, 6, 19, 74, 80, 83
Methylchlorosilane	2.3	2.1, 8	UN2534	—	4, 17, 19, 63, 73
Methyl mercaptan	2.3	2.1	UN1064	—	5, 6, 15, 19, 63, 74, 80, 83
Nitrosyl chloride	2.3	8	UN1069	—	5, 6, 19, 52, 53, 74, 80, 83
Phosgene	2.3	8	UN1076	—	6, 15, 38, 72
Sulphur dioxide	2.3	8	UN1079	—	5, 7, 19, 51, 74, 80, 83
Sulphuryl fluoride	2.3		UN2191	—	5, 54, 75
Trifluoroacetyl chloride	2.3	8	UN3057	—	4, 17, 19, 73
Trifluorochloroethylene, stabilized (Refrigerant gas R 1113)	2.3	2.1	UN1082	—	4, 19, 63, 74
Dangerous Goods of Class 2.3, not listed above	2.3		—	—	P
Class 3 Packing Group I Dangerous Goods					
Acetaldehyde	3		UN1089	I	21, 86
Acrylonitrile, stabilized	3	6.1	UN1093	I	17, 86
Allyl chloride	3	6.1	UN1100	I	66, 86
Carbon disulphide	3	6.1	UN1131	I	21, 86
Chloroprene, stabilized	3	6.1	UN1991	I	36, 86
Flammable liquid, n.o.s.	3		UN1993	I	86

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Organochlorine pesticide, liquid, flammable, toxic, flash point less than 23°C (73°F)	3	6.1	UN2762	I	66, 86
Petroleum crude oil	3		UN1267	I	86
Petroleum sour crude oil, flammable, toxic	3	6.1	UN3494	I	86
Dangerous Goods of Class 3, Packing Group I, not listed above	3		—	I	86
Class 3 Packing Group II Dangerous Goods					
Alcohols, n.o.s.	3		UN1987	II	86
1,1-Dichloroethane	3		UN2362	II	66, 86
1,2-Dichloroethylene	3		UN1150	II	66, 86
Ethanol and gasoline mixture or ethanol and motor spirit mixture or ethanol and petrol mixture, with more than 10 percent ethanol	3		UN3475	II	86
Ethylene dichloride	3	6.1	UN1184	II	66, 86
Flammable liquid, n.o.s.	3		UN1993	II	86
4-Methylmorpholine (n-Methylmorpholine)	3	8	UN2535	II	14, 86
Methyltrichlorosilane	3	8	UN1250	II	14, 86
Organochlorine pesticide, liquid, flammable, toxic, flashpoint less than 23°C (73°F)	3	6.1	UN2762	II	66, 86
Petroleum crude oil	3		UN1267	II	86
Petroleum sour crude oil, flammable, toxic	3	6.1	UN3494	II	86
Vinyltrichlorosilane	3	8	UN1305	II	14, 86

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Dangerous Goods of Class 3, Packing Group II, not listed above	3		—	II	86
Class 3 Packing Group III Dangerous Goods					
Alcohols, n.o.s.	3		UN1987	III	86
Chlorobenzene	3		UN1134	III	66, 86
Elevated temperature liquid, flammable, n.o.s., with flash point above 60°C, at or above its flashpoint	3		UN3256	III	67
Flammable liquid, n.o.s.	3		UN1993	III	86
Petroleum crude oil	3		UN1267	III	86
Petroleum sour crude oil, flammable, toxic	3	6.1	UN3494	III	86
Dangerous Goods of Class 3, Packing Group III, not listed above	3		—	III	86
Class 4.1 Packing Group I Dangerous Goods					
Dangerous Goods of Class 4.1, Packing Group I	4.1		—	I	P
Class 4.1 Packing Group II Dangerous Goods					
Aluminum powder, coated	4.1		UN1309	II	1
Cerium, slabs, ingots or rods	4.1		UN1333	II	1
Ferrocerium	4.1		UN1323	II	1
Flammable solid, corrosive, organic, n.o.s.	4.1	8	UN2925	II	1
Flammable solid, organic, n.o.s.	4.1		UN1325	II	1
Flammable solid, toxic, organic, n.o.s.	4.1	6.1	UN2926	II	3
Lead phosphite, dibasic	4.1		UN2989	II	1

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Metal hydrides, flammable, n.o.s.	4.1		UN3182	II	1
Metal powder, flammable, n.o.s.	4.1		UN3089	II	1
Phosphorus sesquisulphide, free from yellow and white phosphorus	4.1		UN1341	II	1
Rubber scrap or Rubber shoddy, powdered or granulated, not exceeding 840 microns and rubber content exceeding 45%	4.1		UN1345	II	1
Solids containing flammable liquid, n.o.s.	4.1		UN3175	II	1
Titanium hydride	4.1		UN1871	II	2
Dangerous Goods of Class 4.1, Packing Group II, not listed above	4.1		—	II	P
Class 4.1 Packing Group III Dangerous Goods					
Aluminum powder, coated	4.1		UN1309	III	1
Aluminum resinate	4.1		UN2715	III	1
Borneol	4.1		UN1312	III	1
Camphor, synthetic	4.1		UN2717	III	1
Cobalt naphthenates, powder	4.1		UN2001	III	1
Dicyclohexylammonium nitrite	4.1		UN2687	III	1
Flammable solid, corrosive, organic, n.o.s.	4.1	8	UN2925	III	3
Flammable solid, organic, n.o.s.	4.1		UN1325	III	1
Flammable solid, toxic, organic, n.o.s.	4.1	6.1	UN2926	III	3

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Hexamethylenetetramine	4.1		UN1328	III	1
Lead phosphite, dibasic	4.1		UN2989	III	1
Magnesium or Magnesium alloys, with more than 50% magnesium, in pellets, turnings or ribbons	4.1		UN1869	III	1
Manganese resinate	4.1		UN1330	III	1
Metaldehyde	4.1		UN1332	III	1
Metal hydrides, flammable, n.o.s.	4.1		UN3182	III	1
Metal powder, flammable, n.o.s.	4.1		UN3089	III	1
Naphthalene, crude or Naphthalene, refined	4.1		UN1334	III	1
Naphthalene, molten	4.1		UN2304	III	2
Nitronaphthalene	4.1		UN2538	III	1
Paraformaldehyde	4.1		UN2213	III	1
Silicon powder, amorphous	4.1		UN1346	III	1
Sulphur	4.1		UN1350	III	1, 2
Sulphur, molten	4.1		UN2448	III	67
Titanium sponge granules or Titanium sponge powders	4.1		UN2878	III	1
Zinc resinate	4.1		UN2714	III	1
Dangerous Goods of Class 4.1, Packing Group III, not listed above	4.1		—	III	P
Class 4.2 Packing Group I Dangerous Goods					
Organometallic substance, solid, pyrophoric, water-reactive	4.2	4.3	UN3393	I	4,18

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Organometallic substance, liquid, pyrophoric, water-reactive	4.2	4.3	UN3394	I	4, 17, 18
Phosphorus white, molten	4.2	6.1	UN2447	I	3, 17, 25
Phosphorus, white or yellow, dry or under water or in solution	4.2	6.1	UN1381	I	3, 17, 25
Pyrophoric liquid, organic, n.o.s.	4.2		UN2845	I	4, 18
Titanium powder, dry	4.2		UN2546	I	3
Dangerous Goods of Class 4.2, Packing Group I, not listed above	4.2		—	I	P
Class 4.2 Packing Group II Dangerous Goods					
Carbon, animal or vegetable origin	4.2		UN1361	II	3
Potassium sulphide, anhydrous or Potassium sulphide, with less than 30% water of crystallization	4.2		UN1382	II	2, 21
Self-heating solid, corrosive, organic, n.o.s.	4.2	8	UN3126	II	2
Self-heating solid, organic, n.o.s.	4.2		UN3088	II	2
Sodium dithionite(Sodium hydrosulphite)	4.2		UN1384	II	2
Sodium methylate	4.2	8	UN1431	II	2
Sodium sulphide, anhydrous or Sodium sulphide, with less than 30% water of crystallization	4.2		UN1385	II	2
Titanium powder, dry	4.2		UN2546	II	2

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Dangerous Goods of Class 4.2, Packing Group II, not listed above	4.2		—	II	P
Class 4.2 Packing Group III Dangerous Goods					
Carbon, activated	4.2		UN1362	III	2
Carbon, animal or vegetable origin	4.2		UN1361	III	2
Copra	4.2		UN1363	III	2
Fibres or Fabrics, animal or vegetable or synthetic, n.o.s., with oil	4.2		UN1373	III	2
Hafnium powder, dry	4.2		UN2545	III	2
Iron oxide, spent or Iron sponge, spent, obtained from coal gas purification	4.2		UN1376	III	1, 22
Seed cake, with more than 1.5% oil and not more than 11% moisture	4.2		UN1386	III	2
Seed cake, with not more than 1.5% oil and not more than 11% moisture	4.2		UN2217	III	2
Self-heating solid, corrosive, organic, n.o.s.	4.2	8	UN3126	III	3
Self-heating solid, organic, n.o.s.	4.2		UN3088	III	2
Self-heating solid, toxic, organic, n.o.s.	4.2	6.1	UN3128	III	3
Titanium powder, dry	4.2		UN2546	III	2
Zirconium scrap	4.2		UN1932	III	1
Dangerous Goods of Class 4.2, Packing Group III, not listed above	4.2		—	III	P
Class 4.3 Packing Group I Dangerous Goods					

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Aluminum phosphide	4.3	6.1	UN1397	I	3
Boron trifluoride dimethyl etherate	4.3	3, 8	UN2965	I	3
Calcium carbide	4.3		UN1402	I	2, 34, 37
Ethyldichlorosilane	4.3	3, 8	UN1183	I	4
Magnesium powder or Magnesium alloys powder	4.3	4.2	UN1418	I	4, 35
Methyldichlorosilane	4.3	3, 8	UN1242	I	3, 14
Methyl magnesium bromide in ethyl ether	4.3	3	UN1928	I	3
Potassium	4.3		UN2257	I	4, 26
Potassium metal alloys, liquid	4.3		UN1420	I	4, 26
Potassium sodium alloys, liquid	4.3		UN1422	I	4, 26
Rubidium	4.3		UN1423	I	3, 13
Sodium	4.3		UN1428	I	5, 41
Trichlorosilane	4.3	3, 8	UN1295	I	4
Dangerous Goods of Class 4.3, Packing Groups I, not listed above	4.3		—	I	P
Class 4.3 Packing Group II Dangerous Goods					
Aluminum carbide	4.3		UN1394	II	3
Aluminum ferrosilicon powder	4.3	6.1	UN1395	II	3
Aluminum smelting by-products or Aluminum remelting by-products	4.3		UN3170	II	3, 78
Barium	4.3		UN1400	II	2
Calcium carbide	4.3		UN1402	II	2, 34, 37
Magnesium powder or Magnesium alloys powder	4.3	4.2	UN1418	II	2, 35

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Magnesium silicide	4.3		UN2624	II	2
Phosphorus pentasulphide, free from yellow and white phosphorus	4.3	4.1	UN1340	II	3, 37
Dangerous Goods of Class 4.3, Packing Groups II, not listed above	4.3		—	II	P
Class 4.3 Packing Group III Dangerous Goods					
Aluminum smelting by-products or Aluminum remelting by-products	4.3		UN3170	III	3, 78
Aluminum silicon powder, uncoated	4.3		UN1398	III	2
Calcium cyanamide, with more than 0.1% calcium carbide	4.3		UN1403	III	2
Calcium manganese silicon	4.3		UN2844	III	2
Ferrosilicon, with 30% or more but less than 90% silicon	4.3	6.1	UN1408	III	1
Magnesium granules, coated, particle size not less than 149 microns	4.3		UN2950	III	1
Magnesium powder or Magnesium alloys powder	4.3	4.2	UN1418	III	2, 35
Dangerous Goods of Class 4.3, Packing Group III, not listed above	4.3		—	III	P
Class 5.1 Dangerous Goods					
Ammonium nitrate, liquid (hot concentrated solution)	5.1		UN2426	—	3
Class 5.1 Packing Group I Dangerous Goods					
Bromine pentafluoride	5.1	6.1, 8	UN1745	I	5, 7, 17, 19, 44, 72

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Bromine trifluoride	5.1	6.1, 8	UN1746	I	4, 17, 19, 44, 73
Hydrogen peroxide, stabilized or Hydrogen peroxide, aqueous solutions, stabilized, with more than 60% hydrogen peroxide	5.1	8	UN2015	I	3, 32, 47, 85
Iodine pentafluoride	5.1	6.1, 8	UN2495	I	3
Oxidizing solid, corrosive, n.o.s.	5.1	8	UN3085	I	3
Oxidizing solid, n.o.s.	5.1		UN1479	I	3
Dangerous Goods of Class 5.1, Packing Group I, not listed above	5.1		—	I	P
Class 5.1 Packing Group II Dangerous Goods					
Calcium hypochlorite, hydrated or Calcium hypochlorite, hydrated mixture, with not less than 5.5% but not more than 16% water	5.1		UN2880	II	1
Chlorate and borate mixture	5.1		UN1458	II	1
Chlorate and magnesium chloride mixture, solid	5.1		UN1459	II	1
Dichloroisocyanuric acid, dry or Dichloroisocyanuric acid salts	5.1		UN2465	II	1
Hydrogen peroxide, aqueous solution, with not less than 20% but not more than 60% hydrogen peroxide (stabilized as necessary)	5.1	8	UN2014	II	3, 32, 47, 85

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Potassium chlorate, aqueous solution	5.1		UN2427	II	2
Potassium nitrate and sodium nitrite mixture	5.1		UN1487	II	46
Sodium chlorate	5.1		UN1495	II	1
Sodium chlorate, aqueous solution	5.1		UN2428	II	2, 14
Dangerous Goods of Class 5.1, Packing Group II, not listed above	5.1		—	II	3
Dangerous Goods of Class 5.1, Packing Group II, Solids, not listed above, having no subsidiary class other than Class 9	5.1		—	II	1
Class 5.1 Packing Group III Dangerous Goods					
Dangerous Goods of Class 5.1, Packing Group III, Liquids	5.1		—	III	2
Dangerous Goods of Class 5.1, Packing Group III, Solids	5.1		—	III	1
Class 5.2 Packing Group I Goods					
Dangerous Goods of Class 5.2, Packing Group I	5.2		—	I	P
Class 5.2 Packing Group II Goods					
Dangerous Goods of Class 5.2, Packing Group II	5.2		—	II	P
Class 5.2 Packing Group III Goods					
Dangerous Goods of Class 5.2, Packing Group III	5.2		—	III	P
Class 6.1 Packing Group I Dangerous Goods					

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Acetone cyanohydrin, stabilized	6.1		UN1541	I	4, 7, 17, 19, 44, 45, 73
Acrolein, stabilized	6.1	3	UN1092	I	5, 7, 17, 19, 28, 44, 72
Allyl alcohol	6.1	3	UN1098	I	4, 17, 19, 44, 73
Allylamine	6.1	3	UN2334	I	4, 17, 19, 44, 73
Allyl chloroformate	6.1	3, 8	UN1722	I	4, 17, 19, 44, 73
Arsenic trichloride	6.1		UN1560	I	4, 17, 19, 44, 73
n-Butyl isocyanate	6.1	3	UN2485	I	4, 17, 19, 44, 73
tert-Butyl isocyanate	6.1	3	UN2484	I	5, 7, 17, 19, 44, 72
Chloroacetone, stabilized	6.1	3, 8	UN1695	I	4, 17, 19, 44, 73
Chloroacetonitrile	6.1	3	UN2668	I	4, 17, 19, 44, 73
Chloroacetyl chloride	6.1	8	UN1752	I	4, 16, 17, 19, 44, 73
2-Chloroethanal	6.1		UN2232	I	4, 17, 19, 44, 73
Chloropicrin	6.1		UN1580	I	4, 15, 17, 19, 44, 73
Crotonaldehyde or Crotonaldehyde, stabilized	6.1	3	UN1143	I	4, 17, 19, 44, 73
Cyclohexyl isocyanate	6.1	3	UN2488	I	4, 17, 19, 44, 73
Diketene, stabilized	6.1	3	UN2521	I	4, 17, 19, 44, 73

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Dimethylhydrazine, symmetrical	6.1	3	UN2382	I	4, 17, 19, 44, 73
Dimethylhydrazine, unsymmetrical	6.1	3, 8	UN1163	I	4, 15, 17, 19, 44, 73
Dimethyl sulphate	6.1	8	UN1595	I	4, 17, 19, 44, 73
Ethyl chloroformate	6.1	3, 8	UN1182	I	4, 17, 19, 44, 73
Ethyldichloroarsine	6.1		UN1892	I	4, 17, 19, 44, 73
Ethyl isocyanate	6.1	3	UN2481	I	5, 7, 17, 19, 44, 72
Ethylene chlorohydrin	6.1	3	UN1135	I	4, 17, 19, 44, 73
Ethylene dibromide	6.1		UN1605	I	4, 17, 19, 44, 73
Ethyleneimine, stabilized	6.1	3	UN1185	I	5, 7, 17, 19, 44, 72
Hexachlorocyclopentadiene	6.1		UN2646	I	4, 17, 19, 44, 73
Hydrocyanic acid, aqueous solution (hydrogen cyanide, aqueous solution) with not more than 20% hydrogen cyanide	6.1		UN1613	I	4, 7, 39, 44, 73
Hydrogen cyanide, solution in alcohol, with not more than 45 percent hydrogen cyanide	6.1	3	UN3294	I	4, 17, 19, 44, 73
Hydrogen cyanide, stabilized, containing less than 3% water	6.1	3	UN1051	I	5, 7, 39, 44, 48, 72
Iron pentacarbonyl	6.1	3	UN1994	I	5, 7, 17, 19, 44, 72

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Isobutyl isocyanate	6.1	3	UN2486	I	5, 7, 17, 19, 44, 72
Isopropyl chloroformate	6.1	3, 8	UN2407	I	4, 17, 19, 44, 73
Isopropyl isocyanate	6.1	3	UN2483	I	5, 7, 17, 19, 44, 72
Methacrylonitrile, stabilized	6.1	3	UN3079	I	4, 17, 19, 44, 73
Methanesulphonyl chloride	6.1	8	UN3246	I	4, 17, 19, 44, 73
Methoxymethyl isocyanate	6.1	3	UN2605	I	5, 7, 17, 19, 44, 72
Methyl bromide and ethylene dibromide mixture, liquid	6.1		UN1647	I	4, 17, 19, 44, 73
Methyl chloroformate	6.1	3, 8	UN1238	I	5, 7, 17, 19, 44, 72
Methyl chloromethyl ether	6.1	3	UN1239	I	5, 7, 17, 19, 44, 72
2-Methyl-2-heptanethiol	6.1	3	UN3023	I	4, 17, 19, 44, 73
Methylhydrazine	6.1	3, 8	UN1244	I	5, 7, 15, 17, 19, 44, 72
Methyl iodide	6.1		UN2644	I	4, 17, 19, 44, 73
Methyl isocyanate	6.1	3	UN2480	I	5, 7, 17, 19, 44, 72
Methyl isothiocyanate	6.1	3	UN2477	I	4, 17, 19, 44, 73
Methyl orthosilicate	6.1	3	UN2606	I	4, 17, 19, 44, 73
Methyl vinyl ketone, stabilized	6.1	3, 8	UN1251	I	5, 7, 17, 19, 44, 72

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Motor fuel anti-knock mixture	6.1		UN1649	I	4, 17
Organochlorine pesticide, liquid, toxic	6.1		UN2996	I	3, 66
Organochlorine pesticide, liquid, toxic, flammable, flashpoint not less than 23°C (73°F)	6.1	3	UN2995	I	3, 66
Organochlorine pesticide, solid, toxic	6.1		UN2761	I	3, 66
Perchloromethyl mercaptan	6.1		UN1670	I	4, 17, 19, 44, 73
Phenylcarbylamine chloride	6.1		UN1672	I	4, 17, 19, 44, 73
Phenyl isocyanate	6.1	3	UN2487	I	4, 17, 19, 44, 73
Phenyl mercaptan	6.1	3	UN2337	I	4, 17, 19, 44, 73
Phosphorus oxychloride	6.1	8	UN1810	I	4, 17, 19, 44, 73
Phosphorus trichloride	6.1	8	UN1809	I	4, 17, 19, 22, 44, 73
Potassium cyanide, solid	6.1		UN1680	I	3, 42
n-Propyl chloroformate	6.1	3, 8	UN2740	I	4, 17, 19, 44, 73
n-Propyl isocyanate	6.1	3	UN2482	I	5, 7, 17, 19, 44, 72
Sodium cyanide, solid	6.1		UN1689	I	3, 42
Sulphuryl chloride	6.1	8	UN1834	I	5, 7, 14, 17, 19, 44, 72
Thiophosgene	6.1		UN2474	I	4, 17, 19, 44, 73

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Titanium tetrachloride	6.1	8	UN1838	I	4, 15, 17, 19, 44, 73
Toxic liquid, flammable, organic, n.o.s.	6.1	3	UN2929	I	3, 66
Toxic, liquid, organic, n.o.s.	6.1		UN2810	I	3, 66
Toxic, solid, organic, n.o.s.	6.1		UN2811	I	3, 66
Toxic by inhalation liquid, n.o.s., with an LC_{50} lower than or equal to 200 ml/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1		UN3381	I	5, 7, 17, 19, 44, 72
Toxic by inhalation liquid, n.o.s., with an LC_{50} lower than or equal to 1000 ml/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1		UN3382	I	4, 17, 19, 44, 73
Toxic by inhalation liquid, flammable, n.o.s., with an LC_{50} lower than or equal to 200 ml/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	3	UN3383	I	5, 7, 17, 19, 44, 72
Toxic by inhalation liquid, flammable, n.o.s., with an LC_{50} lower than or equal to 1000 ml/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	3	UN3384	I	4, 17, 19, 44, 73

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Toxic by inhalation liquid, water reactive, n.o.s., with an LC_{50} lower than or equal to 200 ml/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	4.3	UN3385	I	5, 7, 17, 19, 44, 72
Toxic by inhalation liquid, water reactive, n.o.s., with an LC_{50} lower than or equal to 1000 ml/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	4.3	UN3386	I	4, 17, 19, 44, 73
Toxic by inhalation liquid, oxidizing, n.o.s., with an LC_{50} lower than or equal to 200 ml/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	5.1	UN3387	I	5, 7, 17, 19, 44, 72
Toxic by inhalation liquid, oxidizing, n.o.s., with an LC_{50} lower than or equal to 1000 ml/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	5.1	UN3388	I	4, 17, 19, 44, 73
Toxic by inhalation liquid, corrosive, n.o.s., with an LC_{50} lower than or equal to 200 ml/m^3 and saturated vapour concentration greater than or equal to 500 LC_{50}	6.1	8	UN3389	I	5, 7, 17, 19, 44, 72

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Toxic by inhalation liquid, corrosive, n.o.s., with an LC_{50} lower than or equal to 1000 ml/m^3 and saturated vapour concentration greater than or equal to 10 LC_{50}	6.1	8	UN3390	I	4, 17, 19, 44, 73
Trimethylacetyl chloride	6.1	3, 8	UN2438	I	4, 17, 19, 44, 73
Dangerous Goods of Class 6.1, Packing Group I, Liquids, not listed above	6.1		—	I	3
Dangerous Goods of Class 6.1, Packing Group I, Solids, not listed above	6.1		—	I	2
Class 6.1 Packing Group II Dangerous Goods					
Allyl isothiocyanate, stabilized	6.1	3	UN1545	II	4, 17, 19
Benzyl chloride	6.1	8	UN1738	II	3
Bromoacetone	6.1	3	UN1569	II	P
n-Butyl chloroformate	6.1	3, 8	UN2743	II	4, 17, 19, 44, 73
Carbon tetrachloride	6.1		UN1846	II	3, 66
Chloroanilines, solid	6.1		UN2018	II	3, 66
Chlorocresols solution	6.1		UN2669	II	3, 66
Chlorocresols, solid	6.1		UN3437	II	3, 66
Dibromochloropropanes	6.1		UN2872	II	3, 66
Dichloroisopropyl ether	6.1		UN2490	II	3, 66
Organochlorine pesticide, liquid, toxic	6.1		UN2996	II	3, 66
Organochlorine pesticide, liquid, toxic, flammable, flashpoint not less than 23°C (73°F)	6.1	3	UN2995	II	3, 66

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Organochlorine pesticide, solid, toxic	6.1		UN2761	II	3, 66
Pentachloroethane	6.1		UN1669	II	3, 66
Phenol, molten	6.1		UN2312	II	3, 19
Toxic liquid, flammable, organic, n.o.s.	6.1	3	UN2929	II	3, 66
Toxic liquid, organic, n.o.s.	6.1		UN2810	II	3, 66
Toxic solid, organic, n.o.s.	6.1		UN2811	II	3, 66
Toluidines, liquid	6.1		UN1708	II	2
Dangerous Goods of Class 6.1, Packing Group II, Liquids, not listed above	6.1		—	II	3
Dangerous Goods of Class 6.1, Packing Group II, Solids, not listed above	6.1		—	II	2
Class 6.1 Packing Group III Dangerous Goods					
Bromoform	6.1		UN2515	III	3, 66
Chlorocresols solution	6.1		UN2669	III	3, 66
Chloroform	6.1		UN1888	III	3, 66
Chlorophenols, liquid	6.1		UN2021	III	3, 66
Dibromochloropropanes	6.1		UN2872	III	3, 66
Dibromomethane	6.1		UN2664	III	3, 66
o-Dichlorobenzene	6.1		UN1591	III	3, 66
Dichloromethane	6.1		UN1593	III	3, 66
Hexachlorobenzene	6.1		UN2729	III	3, 66
Hexachlorobutadiene	6.1		UN2279	III	3, 66
Hexachlorophene	6.1		UN2875	III	3, 66
Organochlorine pesticide, liquid, toxic	6.1		UN2996	III	3, 66

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Organochlorine pesticide, liquid, toxic, flammable, flashpoint not less than 23°C (73°F)	6.1	3	UN2995	III	3, 66
Organochlorine pesticide, solid, toxic	6.1		UN2761	III	3, 66
Tetrachloroethylene	6.1		UN1897	III	3, 66
Toxic liquid, organic, n.o.s.	6.1		UN2810	III	3, 66
Toxic solid, organic, n.o.s.	6.1		UN2811	III	3, 66
1,1,1-Trichloroethane	6.1		UN2831	III	3, 66
Trichloroethylene	6.1		UN1710	III	3, 66
Dangerous Goods of Class 6.1, Packing Group III, Liquids, not listed above	6.1		—	III	2
Dangerous Goods of Class 6.1, Packing Group III, Solids, not listed above	6.1		—	III	1
Dangerous Goods of Class 6.1, Packing Group III, not listed above, with a subsidiary classification other than 9	6.1		—	III	3
Class 8 Packing Group I Dangerous Goods					
Boron tribromide	8		UN2692	I	4, 17, 19, 44, 73
Bromine or Bromine solution	8	6.1	UN1744	I	10, 17, 72
Bromine solution (that does not meet the criteria for Hazard Zone A)	8	6.1	UN1744	I	10, 17, 73
Chlorosulphonic acid(with or without sulphur trioxide)	8		UN1754	I	4, 17, 19, 44, 73

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Chromosulphuric acid	8		UN2240	I	3, 14
Fluorosulphonic acid	8		UN1777	I	3, 14
Hydrazine, anhydrous	8	3, 6.1	UN2029	I	3, 21, 32
Hydrazine, aqueous solution, with more than 37% hydrazine, by mass	8	6.1	UN2030	I	3, 21, 32
Hydrofluoric acid and sulphuric acid mixture	8	6.1	UN1786	I	3, 20, 23
Hydrofluoric acid solution, more than 60% hydrogen fluoride	8	6.1	UN1790	I	3, 20, 23
Hydrogen fluoride, anhydrous	8	6.1	UN1052	I	4, 15, 44, 74
Nitrating acid mixture, withmore than 50% nitric acid	8	5.1	UN1796	I	3
Nitric acid, other than red fuming, with more than 70% nitric acid	8	5.1	UN2031	I	3, 32
Nitric acid, red fuming	8	5.1, 6.1	UN2032	I	4, 17, 44, 73
Sulphuric acid, fuming	8	6.1	UN1831	I	3, 49, 87
Sulphur trioxide, stabilized	8		UN1829	I	4, 17, 19, 31, 44, 73
Thionyl chloride	8		UN1836	I	3, 14
Dangerous Goods of Class 8, Packing Group I, not listed above	8		—	I	3
Class 8 Packing Group II Dangerous Goods					
Allyltrichlorosilane, stabilized	8	3	UN1724	II	3, 14
Amyltrichlorosilane	8		UN1728	II	3, 14

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Sulphuric acid, with not more than 51% acid, or Battery fluid, acid	8		UN2796	II	3, 20
Boron trifluoride acetic acid complex, liquid	8		UN1742	II	3, 14
Butyltrichlorosilane	8	3	UN1747	II	3, 14
Chlorophenyltrichlorosilane	8		UN1753	II	3, 14
Dichloroacetyl chloride	8		UN1765	II	3, 14
Dichlorophenyltrichlorosilane	8		UN1766	II	3, 14
Diethyldichlorosilane	8	3	UN1767	II	3, 14
Diphenyldichlorosilane	8		UN1769	II	4, 8
Dodecyltrichlorosilane	8		UN1771	II	3, 14
Ethyl chlorothioformate	8	3	UN2826	II	4, 17, 19, 44, 73
Fluoroboric acid	8		UN1775	II	3, 20
Fluosilicic acid	8		UN1778	II	3, 20
Formic acid, with more than 85% acid by mass	8	3	UN1779	II	3, 27
Hexadecyltrichlorosilane	8		UN1781	II	3, 14
Hexyltrichlorosilane	8		UN1784	II	3, 14
Hydrazine aqueous solution, with more than 37% hydrazine, by mass	8	6.1	UN2030	II	3, 21, 32
Hydrobromic acid	8		UN1788	II	3, 20
Hydrochloric acid	8		UN1789	II	3, 20
Hydrofluoric acid, with not more than 60% hydrogen fluoride	8	6.1	UN1790	II	3, 20
Hypochlorite solution	8		UN1791	II	3, 20
Iodine monochloride, solid	8		UN1792	II	3, 14

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Nitrating acid mixtures, with not more than 50% nitric acid	8		UN1796	II	3
Nitric acid, other than red fuming, with at least 65%, but not more than 70% nitric acid	8	5.1	UN2031	II	3, 32
Nitric acid, other than red fuming, with less than 65% nitric acid	8		UN2031	II	3, 32
Nonyltrichlorosilane	8		UN1799	II	3, 14
Octadecyltrichlorosilane	8		UN1800	II	3, 14
Octyltrichlorosilane	8		UN1801	II	3, 14
Phenylphosphorus dichloride	8		UN2798	II	3, 20
Phenylphosphorus thiodichloride	8		UN2799	II	3, 20
Phenyltrichlorosilane	8		UN1804	II	3, 14
Phosphorus oxybromide	8		UN1939	II	1, 16
Phosphorus oxybromide, molten	8		UN2576	II	3, 16
Phosphorus tribromide	8		UN1808	II	3, 24
Propyltrichlorosilane	8	3	UN1816	II	3, 14
Silicon tetrachloride	8		UN1818	II	3, 14
Sulphuric acid, spent	8		UN1832	II	3, 49, 50
Sulphuric acid, with more than 51% acid	8		UN1830	II	3, 49, 50
Thiophosphoryl chloride	8		UN1837	II	3, 16, 24
Trichloroacetyl chloride	8		UN2442	II	4, 17, 19, 44, 73
Vanadium oxytrichloride	8		UN2443	II	3, 21

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Dangerous Goods of Class 8, Packing Group II, Liquids, not listed above	8		—	II	3
Dangerous Goods of Class 8, Packing Group II, Solids, not listed above	8		—	II	1
Class 8 Packing Group III Dangerous Goods					
Ferric chloride solution	8		UN2582	III	2, 20
Hydrazine aqueous solution, with more than 37% hydrazine, by mass	8	6.1	UN2030	III	3, 21, 32
Hydrobromic acid	8		UN1788	III	3, 20
Hydrochloric acid	8		UN1789	III	3, 20
Dangerous Goods of Class 8, Packing Group III, Liquids, not listed above	8		—	III	2
Dangerous Goods of Class 8, Packing Group III, Solids, not listed above	8		—	III	1
Class 9 Packing Group I Dangerous Goods					
Dangerous Goods of Class 9, Packing Group I, Liquids	9		—	I	2
Dangerous Goods of Class 9, Packing Group I, Solids	9		—	I	1
Class 9 Packing Group II Dangerous Goods					
Asbestos, Amphibole (amosite, tremolite, actinolite, anthophyllite, crocidolite)	9		UN2212	II	1, 71
Polychlorinated biphenyls, Liquid	9		UN2315	II	3, 66

Column 1 Shipping Name and Description	Column 2 Primary Class	Column 3 Subsidiary Class	Column 4 UN Number	Column 5 Packing Group	Column 6 Special Provision
Dangerous Goods of Class 9, Packing Group II, Liquids, not listed above	9		—	II	2
Dangerous Goods of Class 9, Packing Group II, Solids, not listed above	9		—	II	1
Class 9 Packing Group III Dangerous Goods					
Elevated temperature liquid, n.o.s., at or above 100°C (212°F) and below its flashpoint (including molten metals, molten salts, etc.)	9		UN3257	III	67
Elevated temperature solid, n.o.s., at or above 240°C (464°F)	9		UN3258	III	68
Environmentally hazardous substance, solid, n.o.s.	9		UN3077	III	1, 33
Asbestos, Chrysotile	9		UN2590	III	1, 71
Dangerous Goods of Class 9, Packing Group III, Liquids, not listed above	9		—	III	2
Dangerous Goods of Class 9, Packing Group III, Solids, not listed above	9		—	III	1